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NATIONAL DAM INSPECTION PROGRAM. FREETHY DAM (NDI ID NUMBER PA---ETC(U)
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DELAWARE RIVER BASIN

CARLEY BROOK, WAYNE COUNTY

PENNSYLVANIA

LEVEL II

FREETHY DAM

NDI ID NO. PA-00171
DER ID NO. 64-160

RUSSELL COMPTON

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

National Dam Inspection Program. Freethy Dam (NDI ID Number PA-ØØ171, DER ID Number 64-16Ø), Delaware River Basin, Carley Brook, Wayne County, Pennsylvania. Phase I Inspection Report,

Prepared by
GANNETT FLEMING CORDDRY AND CARPENTER, INC.
Consulting Engineers
Harrisburg, Pennsylvania 17105

"Original contains color plates: All DTIC reproductions will be in black and white"

DACW31-81-C-ØØ18

For
DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

MARCH 1981

DELAWARE RIVER BASIN

CARLEY BROOK, WAYNE COUNTY

PENNSYLVANIA

FREETHY DAM

NDI ID No. PA-00171
DER ID No. 64-160

RUSSELL COMPTON

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

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Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

MARCH 1981

PREFACE

This report is prepared under guidance contained in Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

FREETHY DAM

NDI ID No. PA-00171; DER ID No. 64-160

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

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APPENDICES

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

BRIEF ASSESSMENT OF GENERAL CONDITION

AND

RECOMMENDED ACTION

Name of Dam:	Freethy Dam NDI ID No. PA-00171 DER ID No. 64-160
Size:	Small (26 feet high; 89 acre-feet)
Hazard Classification:	High
Owner:	Mr. Russell Compton 185 Tryon Street Honesdale, PA 18431
State Located:	Pennsylvania
County Located:	Wayne
Stream:	Carley Brook
Date of Inspection:	3 December 1980

Based on the criteria established for these studies, Freethy Dam is judged to be unsafe, nonemergency, because the spillway capacity is seriously inadequate. The recommended Spillway Design Flood (SDF) for the size and hazard classification of the dam varies between 1/2 of the Probable Maximum Flood (PMF) and the PMF. Based on the size of the dam and reservoir, the 1/2 PMF is selected as the SDF. The existing spillway will pass only about 2 percent of the PMF before overtopping of the dam occurs. It is judged that the dam could not withstand the depth and duration of overtopping during storms of only 20 percent of the PMF. Failure of the dam would cause an increased hazard for loss of life downstream. Overall, the dam is judged to be in good condition.

No stability problems were observed at the dam during normal operating conditions. However, the stability of the structure is questionable during storms of large magnitude. Maintenance of the dam is generally adequate.

The following studies and remedial measures, listed in approximate order of priority, are recommended to be undertaken by the Owner without delay:

(1) Perform additional studies to more accurately ascertain the spillway capacity required for Freethy Dam, as well as the nature and extent of measures required to provide adequate spillway capacity. Take appropriate action as required.

(2) As part of the studies under (1), a structural stability analysis of the dam should be made. Take appropriate action as required.

(3) Perform a detailed inspection of the 30-inch diameter outlet pipe. Take appropriate action as required.

(4) Visually monitor the seepage at the right abutment of the dam. If the condition worsens, take appropriate action as required.

(5) Replace the stones missing from the downstream face of the dam.

All investigations, studies, designs, and inspection of construction should be performed by a professional engineer experienced in the design and construction of dams.

In addition, the Owner should institute the following operational and maintenance procedures:

(1) Develop a detailed emergency operation and warning system for Freethy Dam. When warnings of a major storm are given by the National Weather Service, the Owner should activate the emergency operation and warning system.

(2) During periods of unusually heavy rains, provide round-the-clock surveillance of the dam.

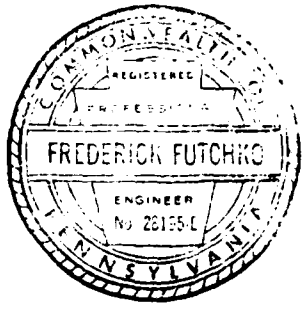
(3) Initiate an inspection program such that the dam is inspected on a regular basis. As presently required by the Commonwealth, the inspection program should include a formal annual inspection by a professional engineer experienced in the design and construction of dams. Utilize the inspection results to determine if remedial measures are necessary.

(4) Continue the existing maintenance program and develop a formal maintenance manual so that all features of the dam are properly maintained.

FREETHY DAM

Submitted by:

GANNETT FLEMING CORDDRY
AND CARPENTER, INC.



FREDERICK FUTCHKO
Project Manager, Dam Section

Date: 13 April 1981

Approved by:

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF
ENGINEERS

JAMES W. PECK
Colonel, Corps of Engineers
District Engineer

Date: 11 MAY 81

FREETHY DAM

Overview

FREETHY DAM

NDI ID No. PA-00171; DER ID No. 64-160

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

SECTION 1

PROJECT INFORMATION

1.1 General.

a. Authority. The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

b. Purpose. The purpose of the inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

a. Dam and Appurtenances. Freethy Dam is a 26-foot high dry stone masonry gravity dam with a concrete cap. The dam is 100 feet long (including the 46.4-foot long spillway) and has top widths of 11.7 feet at the left end of the dam and 16.5 feet at the right end of the dam. Both the upstream and downstream faces are nearly vertical. The dam is founded on red and gray shale.

The spillway consists of a triangular-shaped concrete weir which discharges in a straight drop to the streambed below the dam. The weir overhangs the face of the dam 2 feet and has a crest elevation which is 1.7 feet below the minimum top of dam. A typical cross-section of the spillway is shown on Plate E-2.

The outlet works consists of a 30-inch gated steel outlet pipe located to the right of the spillway. The invert of the outlet end of the pipe is 20.5 feet below the top of dam. The manually operated gate controls are located in a small gate house on the top of the dam.

The various features of the dam are shown on the photographs in Appendix C. A description of the geology is included in Appendix F.

b. Location. Freethy Dam is located on Carley Brook in the Borough of Honesdale, Wayne County, Pennsylvania. The dam is shown on USGS Quadrangle, White Mills, Pennsylvania, at latitude N 41° 33.8' and longitude W 75° 14.5'. A location map is shown on Plate E-1.

c. Size Classification. Small (26 feet high, 89 acre-feet).

d. Hazard Classification. Downstream conditions indicate that a high hazard classification is warranted for Freethy Dam (Paragraphs 3.1e and 5.1c).

e. Ownership. Mr. Russell Compton, 185 Tryon Street, Honesdale, Pennsylvania 18431.

f. Purpose of Dam. Recreation.

g. Design and Construction History. The dam was constructed prior to 1900 by the D and H Canal Company, the original owners of the dam. Ownership was, at some later date, transferred to the Carley Brook Sand and Gravel Works. No information is available concerning the dam until 1958 when the concrete cap, spillway, and concrete facing at the toe and on the upstream face of the dam were constructed. The concrete placed on the upstream side of the dam reportedly covers the entire face and has an average thickness of 4 inches. The dam has remained in essentially the same condition since completion of these modifications.

h. Normal Operational Procedure. The reservoir pool is maintained at the spillway crest level with excess inflows discharging over the spillway. Although it is seldom used, the outlet works can be used to draw down the reservoir.

1.3 Pertinent Data.

a. Drainage Area. (square miles) 12.3

b. Discharge at Damsite (cfs)

Maximum known flood	Unknown
Outlet works at maximum pool elevation	128
Spillway capacity at maximum pool elevation	319

c. Elevation. (feet above msl.)

Top of dam	1036.7
Maximum pool	1036.7
Normal pool (spillway crest)	1035.0
Upstream invert outlet works	Unknown
Downstream invert outlet works	1016.2
Streambed at toe of dam	1011.0

d.	Reservoir Length. (miles)	
	Normal pool	0.50
	Maximum pool	0.55
e.	Storage. (acre-feet)	
	Normal pool	72
	Maximum pool	89
f.	Reservoir Surface. (acres)	
	Normal pool	9
	Maximum pool	11
g.	Dam.	
	Type	Stone masonry gravity
	Length (feet)	100, including spillway
	Height (feet)	26
	Top Width (feet)	16.5
	Side Slopes Upstream and Downstream	Nearly Vertical
	Zoning	Unknown
	Cutoff	Unknown
	Grout Curtain	None
h.	Diversion and Regulating Tunnel.	None
i.	Spillway.	
	Type	Triangular-shaped, concrete weir
	Length of Weir (feet)	46.4
	Crest Elevation (feet above msl.)	1035.0
	Upstream Channel	Reservoir
	Downstream Channel	Natural stream

j.	Regulating Outlets.	30-inch diameter steel outlet pipe with manually operated gate at upstream end

SECTION 2

ENGINEERING DATA

2.1 Design.

a. Data Available. No design data are available for the dam or subsequent modifications.

b. Design Features. The project is described in Paragraph 1.2a. The various features of the dam are shown on the photographs in Appendix C and on Plate E-2.

c. Design Considerations. The design of the dam cannot be assessed from the available data.

2.2 Construction.

a. Data Available. There are no construction data available for Freethy Dam.

b. Construction Considerations. The construction of the dam cannot be assessed from the available data.

2.3 Operation. There are no formal records of operation. An inspection of the dam was performed by the Commonwealth in 1965. A summary of the inspection report is included in Appendix A.

2.4 Evaluation.

a. Availability. The correspondence file for the dam was provided by the Bureau of Dams and Waterway Management, Department of Environmental Resources, Commonwealth of Pennsylvania (PennDER). The Owner was available for information following the visual inspection.

b. Adequacy. The type and amount of available design and other engineering information are limited. The assessment of the dam is based on the combination of available data, visual inspection, performance history, hydrologic and hydraulic assumptions, and calculations developed for this report.

c. Validity. There is no reason to question the validity of the available data.

SECTION 3

VISUAL INSPECTION

3.1 Findings.

a. General. The overall appearance of the dam and appurtenant structures is good. Noteworthy deficiencies observed are described in the following paragraphs. The complete visual inspection checklist and sketch of the dam are presented in Appendix B. A profile of the top of the dam and a typical cross-section of the spillway are included in Appendix E. On the day of the inspection, the reservoir pool was approximately 0.1 foot above the spillway crest.

b. Dam. Overall, the dam is in good condition. There are a few stones missing from the downstream face. Clear seepage was observed at the right abutment contact approximately 15 feet below the top of the dam. The flow was estimated at 30 gallons per minute (gpm.). Red shale was observed at the right abutment, just above and below the elevation of the top of the dam. Gray shale outcrops about halfway down at the right abutment and about 6 feet below the top of dam at the left abutment. The concrete cap is in good condition. It varies from 3 inches to 6 inches thick on the downstream edge. Most of the concrete facing on the upstream face was submerged and could not be observed. The portion of it above the water level, however, was in good condition.

c. Appurtenant Structures. The spillway is in good condition. The concrete shows no signs of excessive deterioration. Most of the outlet works facilities were unobservable as the intake structure was submerged and the gate house was locked. The exit end of the outlet pipe is rusted. A small amount of flow was discharging from the pipe at the time of the inspection. Because of the condition and size of the pipe, a detailed inspection was not made of the inside of the pipe. The gate house is in good condition. The Owner indicated that the gate house is secured to the dam to prevent washout during overtopping of the dam.

d. Reservoir Area. The reservoir slopes are relatively steep and partially wooded. No evidence of any landslide activity was observed. During the inspection, soundings were taken along the upstream side of the dam. They indicate that there may be several feet of sedimentation in the reservoir.

e. Downstream Conditions. A stone masonry, horseshoe-shaped road culvert, 24 feet high, is located approximately 150 feet downstream from Freethy Dam. The stream channel downstream from the culvert is deep and steeply sloping. The streambed is composed of gray shale. Erosion patterns in the shale indicate that the rock is of variable hardness. Several apartment buildings and at least 5 houses are located along the stream channel between the dam and the Lackawaxen River located approximately 1,500 feet downstream. It is likely that several of these residences would be flooded in the event of a dam failure, possibly resulting in the loss of three or more lives. Accordingly, a high hazard classification has been assigned to Freethy Dam.

SECTION 4

OPERATIONAL PROCEDURES

4.1 Procedure. The reservoir is normally maintained at the level of the spillway crest with excess inflows discharging over the spillway and into the downstream channel.

4.2 Maintenance of Dam. There are no established procedures for maintenance of the dam. Maintenance work has generally been performed as required. The dam is checked on a regular basis by the Owner; however, no formal reports are maintained.

4.3 Maintenance of Operating Facilities. There is no established procedure for maintenance of the outlet works facilities. The Owner stated that the outlet works is operable. It is not, however, operated on a regular basis.

4.4 Warning Systems in Effect. There is no emergency operation and warning system for the dam.

4.5 Evaluation of Operational Adequacy. The maintenance of the dam is generally adequate. Inspections are necessary to detect hazardous conditions at the dam. An emergency operation and warning system is necessary to reduce the risk of dam failure should adverse conditions develop and to prevent loss of life should the dam fail.

SECTION 5

HYDROLOGY AND HYDRAULICS

5.1 Evaluation of Features.

a. Design Data. There are no hydrologic or hydraulic design calculations available for Freethy Dam.

b. Experience Data. Major floods occurred in the area in which Freethy Dam is located in July 1952 and August 1955. It is reported that the dam suffered no damage during either of the floods. No accurate rainfall, runoff, or reservoir level records are available for either of these storms. It is likely, however, based on a comparison of stream flow records from nearby watercourses (see Appendix D), that Freethy Dam experienced a significant amount of overtopping during both storms. The Owner reported that the dam has been overtopped several times by approximately one foot of water.

c. Visual Observations.

(1) General. The visual inspection of Freethy Dam, which is described in Section 3, resulted in a number of observations relevant to hydrology and hydraulics.

(2) Dam. Gray shale outcrops at the left abutment approximately 6 feet below the top of the dam. Above this shale is a layer of weathered rock which would be subject to erosion if excessive overtopping of the dam occurred. Such erosion could lead to loss of the concrete cap on the top of the dam and subsequent erosion of the stone masonry below it. The remainder of the dam could withstand greater depths of overtopping.

(3) Appurtenant Structures. No condition was observed that would indicate that the spillway could not operate satisfactorily during high reservoir stages. The outlet works has no significant effect on the hydraulic adequacy of the structure. Discharges through the outlet works were not included in the hydrologic and hydraulic analyses.

(4) Reservoir Area. The reservoir slopes are relatively steep and partially wooded. The watershed is approximately 1/2 woodland and 1/2 farmland and has several ponds and reservoirs located within its boundaries. Descriptions of the reservoirs which were included in the hydrologic and hydraulic analyses are included in Appendix D.

(5) Downstream Conditions. A stone masonry, horseshoe-shaped road culvert, 24 feet high, is located approximately 150 feet downstream from Freethy Dam. The culvert is not likely to attenuate the discharge to the downstream area, but could substantially increase tailwater stages at the dam. The stream channel downstream from the culvert is deep and steeply sloping. Several apartment buildings and at least 5 houses are located along the stream between Freethy Dam and the Lackawaxen River located approximately 1500 feet downstream. Failure of Freethy Dam would result in flooding of these structures. A high hazard classification is, therefore, warranted for Freethy Dam.

d. Overtopping Potential.

(1) Spillway Design Flood. According to the criteria established by the Office of the Chief of Engineers (OCE), the Spillway Design Flood (SDF) for the size (small) and hazard potential (high) of Freethy Dam is between one-half of the Probable Maximum Flood (PMF) and the PMF. Because the dam and reservoir are on the low end of the small size category, the 1/2 PMF was selected as the SDF for Freethy Dam. The watershed and reservoir were modeled with the U.S. Army Corps of Engineers' HEC-1DB computer program. A description of this computer program is included in Appendix D. The assessment of the hydrology and hydraulics is based on existing conditions, and the effects of future development are not considered.

(2) Summary of Results. Pertinent results are tabulated at the end of Appendix D. The analysis reveals that Freethy Dam can pass about 2 percent of the PMF before overtopping of the dam occurs.

(3) Spillway Adequacy. The criteria used to evaluate the spillway adequacy are described in Appendix D. Because of the depth and duration of overtopping of the dam during a storm of only 20 percent of the PMF, it was assumed that the dam would fail under such conditions. A breach analysis was performed to ascertain the impact of failure on the downstream area. The conditions contributing to the failure of the dam, as well as its failure mode, are also included in Appendix D. It was found that failure of the dam during 20 percent of the PMF could cause water levels at the damage area to rise 3 to 4 feet above levels that would exist if the dam were not to fail. This increased depth of flooding in the downstream area could contribute to a substantial increase in damages caused by discharges from the reservoir. The spillway is, therefore, rated as seriously inadequate.

SECTION 6

STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations.

(1) General. The visual inspection of Freethy Dam, which is described in Section 3, resulted in a number of observations relevant to structural stability. These observations are evaluated herein for the various features.

(2) Dam. The stones missing from the downstream face of the dam do not constitute a serious threat to the stability of the dam for the normal pool condition. However, for a flood condition which results in overtopping, the missing stones could hasten failure of the dam. The seepage at the toe of the dam is not considered to be an immediate hazard, but it should be monitored. If seepage increases it could become a hazard.

The stability of the dam during storm events equal to or less than the SDF is questionable. Very little information is available concerning the foundation of the dam, the materials used in its construction, and the dimensions of the upstream side of the dam.

(3) Appurtenant Structures. During normal operating conditions the spillway and outlet works pose no threat to the stability of Freethy Dam.

b. Design and Construction Data. No stability calculations are available for the dam.

c. Operating Records. There are no operating records maintained for Freethy Dam and Reservoir. The normal operating procedures followed by the Owner do not indicate cause for concern relative to the structural integrity of the dam.

d. Post-construction Changes. The modifications listed previously are not considered to adversely affect the structural stability of the dam.

e. Seismic Stability. Freethy Dam is located in Seismic Zone 1 where earthquake loadings are not considered to be significant for small dams with no readily apparent stability problems. Since no readily apparent stability problems were observed, the seismic stability of the dam is assumed to be adequate.

SECTION 7

ASSESSMENT, RECOMMENDATIONS, AND PROPOSED REMEDIAL MEASURES

7.1 Dam Assessment.

a. Safety.

(1) Based on the criteria established for these studies, Freethy Dam is judged to be unsafe, nonemergency, because the spillway capacity is seriously inadequate. The recommended Spillway Design Flood (SDF) for the size and hazard classification of the dam varies between the 1/2 PMF and the PMF. Based on the size of the dam and reservoir, the 1/2 PMF is selected as the SDF. The existing spillway will pass about 2 percent of the PMF before overtopping of the dam occurs. It is judged that the dam could not withstand the depth and duration of overtopping during storms of only 20 percent of the PMF. Failure of the dam would cause an increased hazard for loss of life downstream. Overall, the dam is judged to be in good condition.

(2) No stability problems were observed at the dam during normal operating conditions. However, the stability of the structure is questionable during storms of large magnitude.

(3) Maintenance of the dam is generally adequate.

(4) A summary of the features of the dam and observed deficiencies is listed below:

Feature	Observed Deficiency
Dam	Seepage at right abutment; stones missing from downstream face.
Spillway	No deficiencies.
Outlet Works	Rusted outlet pipe; leakage.

b. Adequacy of Information. The information available is such that a preliminary assessment of the condition of the dam can be inferred from the combination of available information, visual inspection, past performance, and computations performed as part of this study. The information is not adequate, however, to evaluate the structural stability of the dam during the 1/2 PMF or lesser storms.

c. Urgency. The recommendations in Paragraph 7.2 should be implemented without delay.

d. Necessity for Further Investigations. In order to accomplish the remedial measures outlined in Paragraph 7.2, further investigations by the Owner will be required.

7.2 Recommendations and Remedial Measures.

a. The following studies and remedial measures, listed in approximate order of priority, are recommended to be undertaken by the Owner without delay:

(1) Perform additional studies to more accurately ascertain the spillway capacity required for Freethy Dam as well as the nature and extent of measures required to provide adequate spillway capacity. Take appropriate action as required.

(2) As part of the studies under (1), a structural stability analysis of the dam should be made. Take appropriate action as required.

(3) Perform a detailed inspection of the 30-inch diameter outlet pipe. Take appropriate action as required.

(4) Visually monitor the seepage at the right abutment of the dam. If the condition worsens, take appropriate action as required.

(5) Replace the stones missing from the downstream face of the dam.

All investigations, studies, designs, and inspection of construction should be performed by a professional engineer experienced in the design and construction of dams.

b. In addition, the Owner should institute the following operational and maintenance procedures:

(1) Develop a detailed emergency operation and warning system for Freethy Dam. When warnings of a major storm are given by the National Weather Service, the Owner should activate the emergency operation and warning system.

(2) During periods of unusually heavy rains, provide round-the-clock surveillance of the dam.

(3) Initiate an inspection program such that the dam is inspected on a regular basis. As presently required by the Commonwealth, the inspection program should include a formal annual inspection by a professional engineer experienced in the design and construction of dams. Utilize the inspection results to determine if remedial measures are necessary.

(4) Continue the existing maintenance program and develop a formal maintenance manual so that all features of the dam are properly maintained.

APPENDIX A

CHECKLIST - ENGINEERING DATA

CHECKLIST

ENGINEERING DATA

DESIGN, CONSTRUCTION, AND OPERATION
PHASE I

NAME OF DAM: FREETHY DAM

NDI ID NO.: PA-00171 DER ID NO.: 64-160

Sheet 1 of 4

ITEM	REMARKS
AS-BUILT DRAWINGS	None
REGIONAL VICINITY MAP	See Plate E-1
CONSTRUCTION HISTORY	Not available
TYPICAL SECTIONS OF DAM	A typical cross-section of the spillway is shown on plate E-2.
OUTLETS: Plan Details Constraints Discharge Ratings	A discharge rating is included in Appendix D; no other information is available.

ENGINEERING DATA

ITEM	REMARKS
RAINFALL/RESERVOIR RECORDS	None
DESIGN REPORTS	None
GEOLOGY REPORTS	None
DESIGN COMPUTATIONS: Hydrology and Hydraulics Dam Stability Seepage Studies	None
MATERIALS INVESTIGATIONS: Boring Records Laboratory Field	None
POSTCONSTRUCTION SURVEYS OF DAM	None

ENGINEERING DATA

ITEM	REMARKS
BORROW SOURCES	Unknown
MONITORING SYSTEMS	None
MODIFICATIONS	Described in Section 1 of this report; no other information available.
HIGH POOL RECORDS	None maintained
POSTCONSTRUCTION ENGINEERING STUDIES AND REPORTS	None
PRIOR ACCIDENTS OR FAILURE OF DAM: Description Reports	None

ENGINEERING DATA

ITEM	REMARKS
MAINTENANCE AND OPERATION RECORDS	None
SPILLWAY: Plan Sections Details	See Exhibit B-1 and Plate E-2
OPERATING EQUIPMENT: Plans Details	None
PREVIOUS INSPECTIONS Dates Deficiencies	March 1965 - (Inspected by Commonwealth) Overall condition - OK

APPENDIX B

CHECKLIST - VISUAL INSPECTION

CHECKLIST

VISUAL INSPECTION

PHASE I

Name of Dam: Freethy Dam County: Wayne State: Pennsylvania

NDI ID No.: PA-00171 DER ID No.: 64-160

Type of Dam: Stone-masonry gravity Hazard Category: High

Date(s) Inspection: 3 December 1980 Weather: Party cloudy, windy Temperature: 27°F

Pool Elevation at Time of Inspection: 1035.1 ft. msl/Tailwater at Time of Inspection: 1012 ± ft. msl

Note: Elevations referenced to USGS quadrangle White Mills, PA.

Inspection Personnel:

R.E. Holderbaum (GFCC)

D.B. Wilson (GFCC)

D.B. Wilson Recorder

CONCRETE/MASONRY DAMS

Sheet 1 of 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	Seepage at right abutment 15.5 feet below top of dam; ~30 gpm.	Non-damaging at present; could eventually increase and cause erosion of shale; recommend monitoring.
JUNCTION OF STRUCTURE WITH: Abutment Embankment Other Features	Right abutment - red shale; Left abutment - rock outcrops six feet below top of dam.	Left abutment probably could not withstand great depths of overtopping.
DRAINS	None observed.	
WATER PASSAGES	Outlet conduit - see OUTLET WORKS	
FOUNDATION	Red shale outcrops at top of right abutment - gray shale outcrops ~ halfway down; Gray shale outcrops at left abutment ~6 ft. below top of dam	Gray shale in streambed below dam; erosion patterns in streambed indicate variable hardness.

CONCRETE/MASONRY DAMS

Sheet 2 of 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SURFACES: Surface Cracks Spalling	Concrete cap is in good condition - slab thickness indeterminate; D/s side (right) is ~6" - D/s side (left) ~3"; U/s sides have concrete to	below water level; If concrete cap were lost during flood stone masonry would erode rapidly.
STRUCTURAL CRACKING	None apparent	
ALIGNMENT: Vertical Horizontal	Vertical - see plate E-2 Horizontal - good	Top of dam is nearly level.
MONOLITH JOINTS	N/A	
CONSTRUCTION JOINTS	A few stones are missing from the downstream face of the dam.	Stones should be replaced.
STAFF GAGE OR RECORDER	None	

OUTLET WORKS

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	30" ϕ steel pipe; badly rusted at downstream end; some discharge from pipe.	Recommend detailed inspection of conduit.
INTAKE STRUCTURE	Channel at right end of spillway - unobstructed.	
OUTLET STRUCTURE	None - projecting steel pipe on downstream face.	
OUTLET CHANNEL	None	
EMERGENCY GATE	Gatehouse at top of dam locked during inspection - mechanisms unknown.	The owner indicated that the gate was operated three years ago.

UNGATED SPILLWAY

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Good condition - no deficiencies observed.	
APPROACH CHANNEL	Reservoir - no obstructions or debris.	
DISCHARGE CHANNEL	Natural stream channel in gray shale bedrock.	
BRIDGE AND PIERS	None	

INSTRUMENTATION

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None	
OBSERVATION WELLS	None	
WEIRS	None	
PIEZOMETERS	None	
OTHER		

DOWNSTREAM CHANNEL

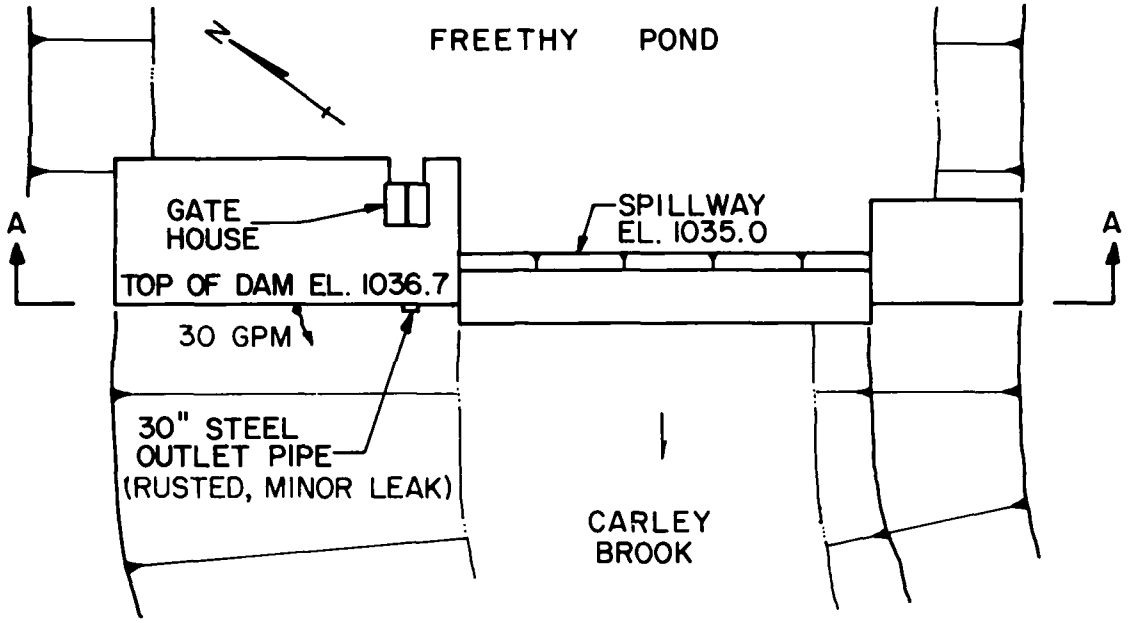
Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION: Obstructions Debris Other	24 ft. high masonry horseshoe culvert and bridge approx. 150 ft. D/S; 10ft (±) waterfall just D/S from culvert.	
SLOPES	steep to vertical rock slopes; no evidence of slides (although possible); bed slope of stream very steep.	Significant erosion of rock has occurred in some areas.
APPROXIMATE NUMBER OF HOMES AND POPULATION	several apartment buildings and at least 5 houses are located along the stream channel between the dam and the Lackawaxen River approximately 1500 feet downstream.	High hazard

RESERVOIR AND WATERSHED

Sheet 1 of 1

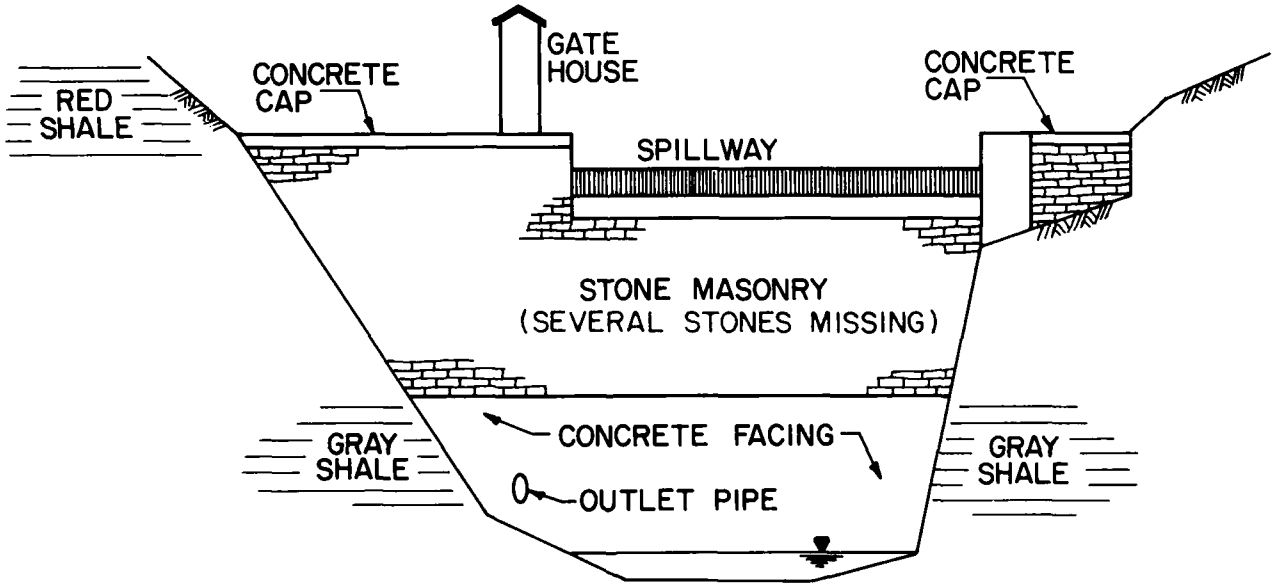
VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Moderate to steep; partially wooded.	
SEDIMENTATION	Possible sedimentation as indicated by soundings taken on upstream side of dam.	
WATERSHED DESCRIPTION	Approximately 1/2 farmland and 1/2 wooded; several ponds and other reservoirs located within watershed.	See Appendix D for description of reservoirs included in hydrologic and hydraulic analysis.



PLAN VIEW

SCALE: 1 IN. = 20 FT. ±

20 0 20 40



CROSS-SECTION A-A

SCALE: HORIZ.- 1 IN. = 20 FT. ±
VERT.- 1 IN. = 10 FT. ±

DATE OF INSPECTION: 3 DECEMBER 1980
POOL ELEVATION : 1035.1 FEET

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

FREETHY DAM

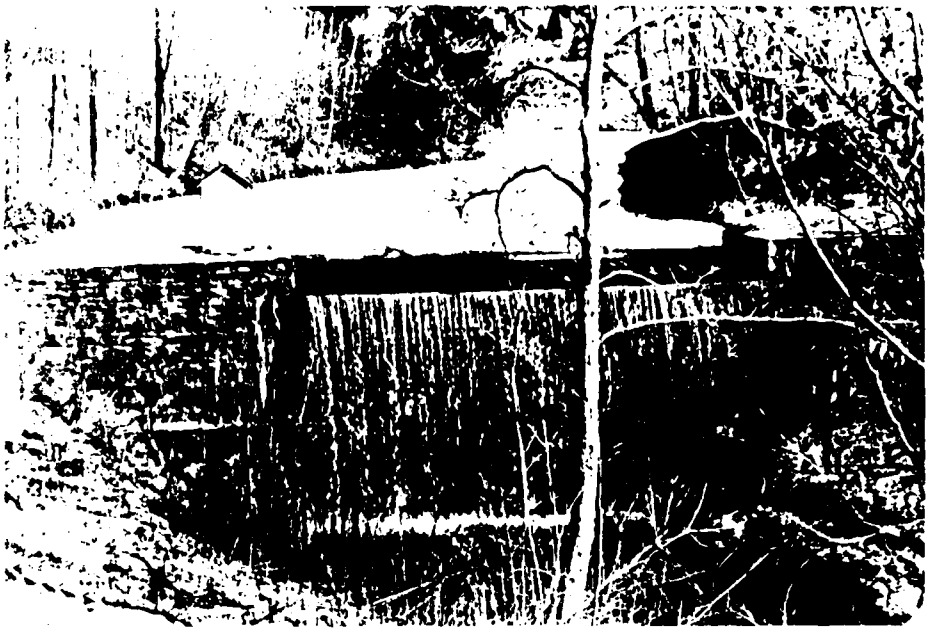
RUSSELL COMPTON

RESULT OF VISUAL INSPECTION

MARCH 1981 EXHIBIT B-1

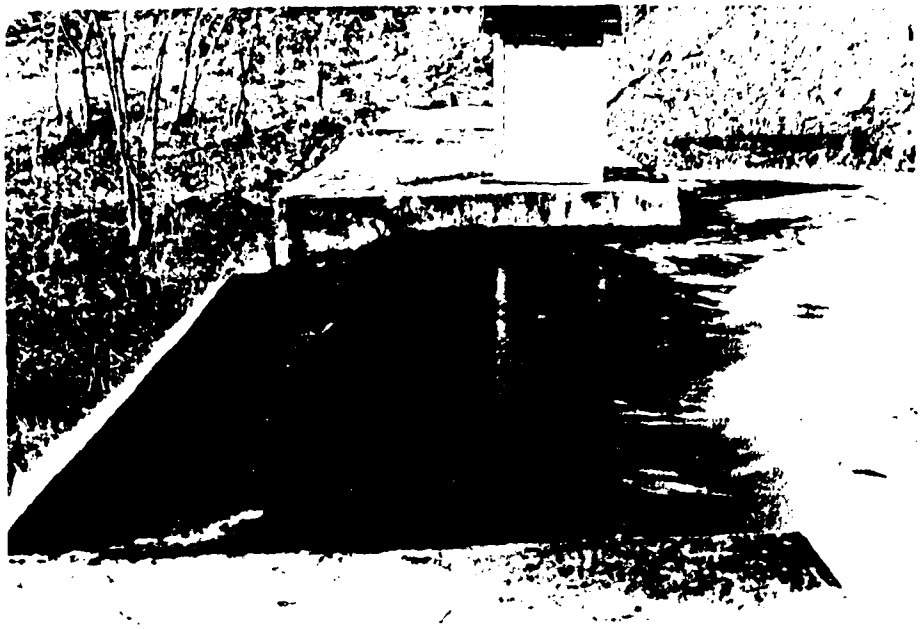
APPENDIX C

PHOTOGRAPHS



A. Dam and Reservoir.

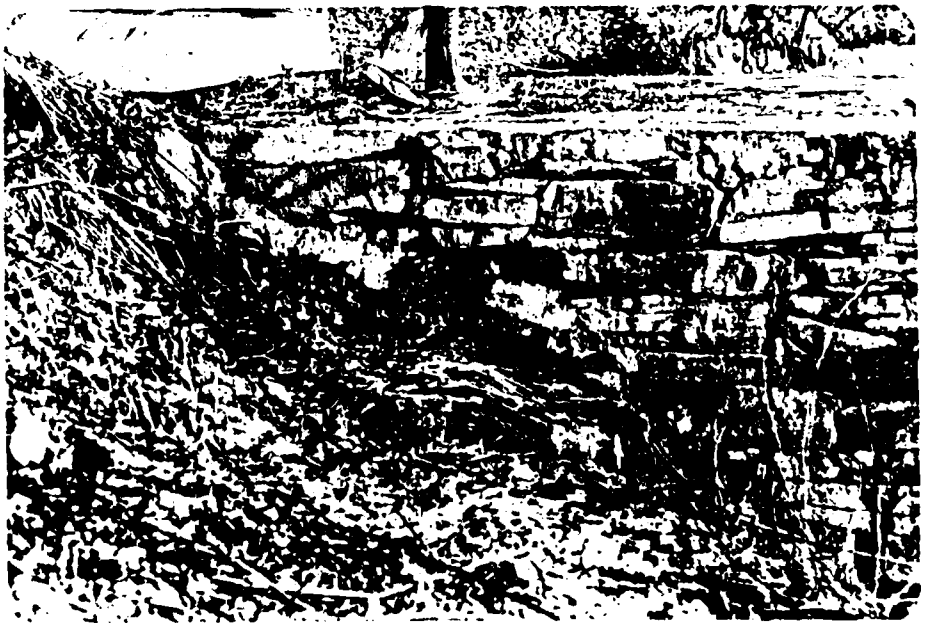
B. Dam - From Right Abutment.



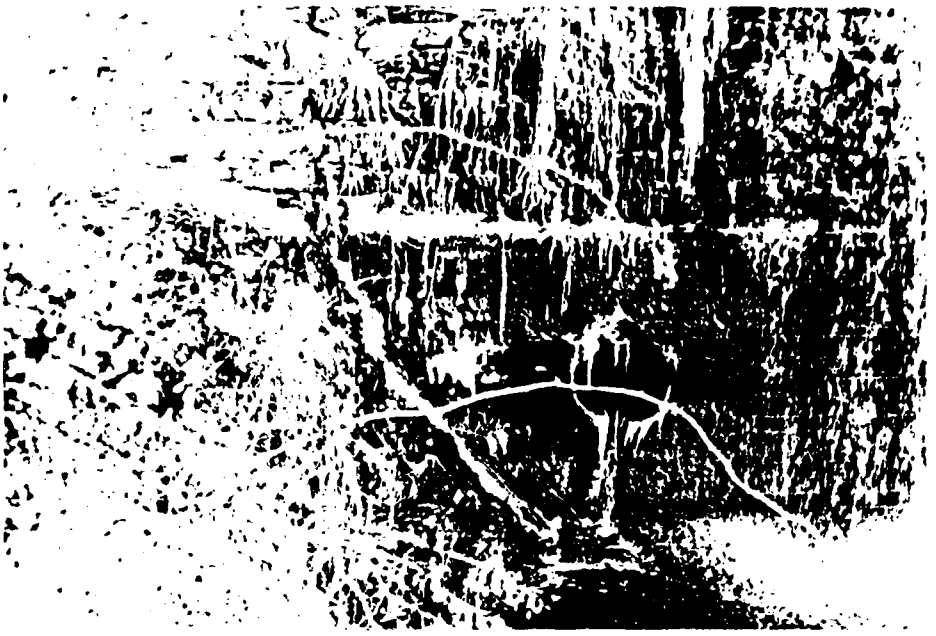
C. Spillway - Looking Toward Right End of Dam.

D. Spillway Slab.

E. Left Abutment of Dam.

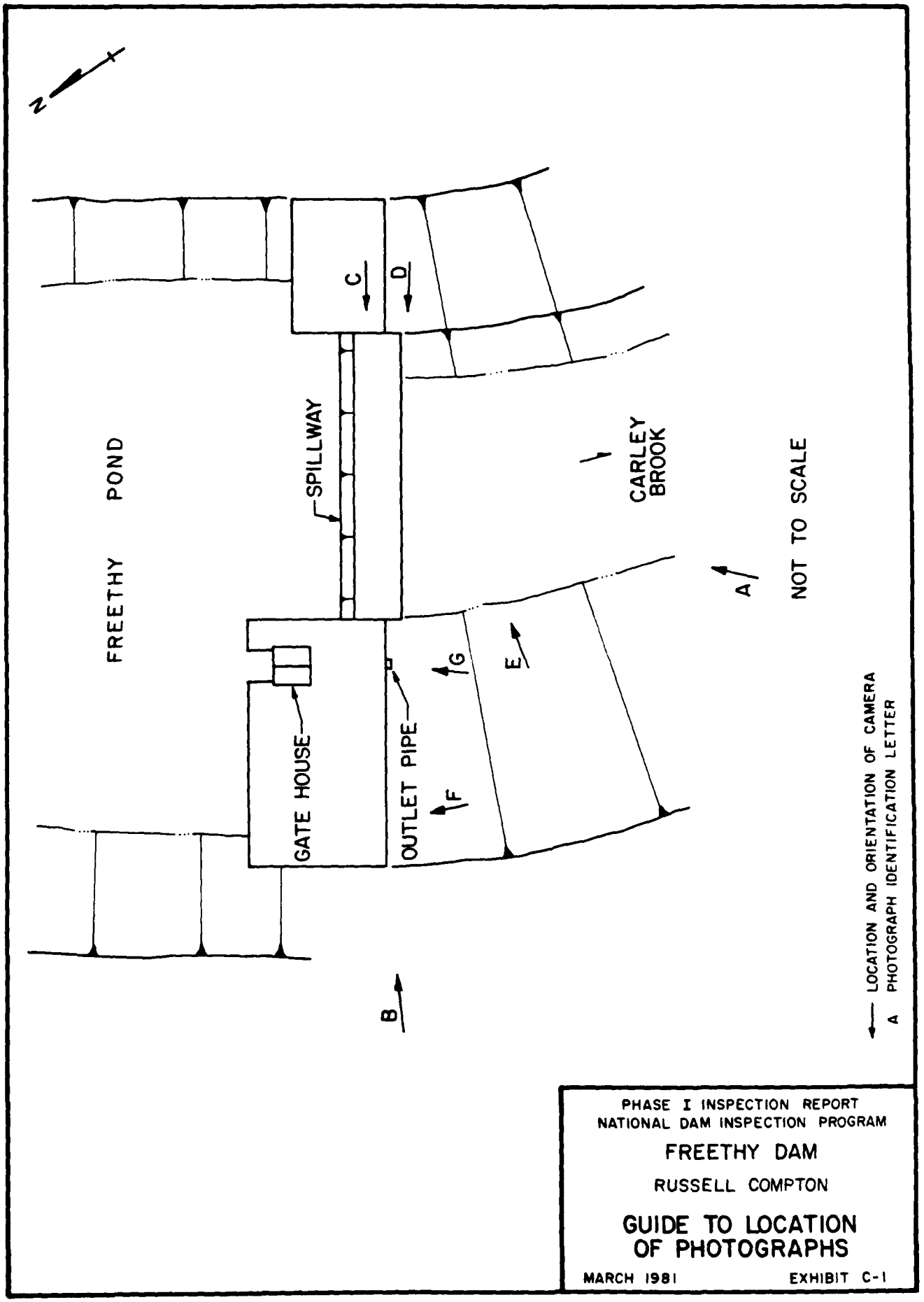


F. Right End of Dam - Downstream Side.



G. Exit End of Outlet Conduit.

H. Downstream Channel.



PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

FREETHY DAM

RUSSELL COMPTON

GUIDE TO LOCATION OF PHOTOGRAPHS

MARCH 1981 EXHIBIT C-1

APPENDIX D

HYDROLOGY AND HYDRAULICS

APPENDIX D

HYDROLOGY AND HYDRAULICS

Spillway Capacity Rating:

In the recommended Guidelines for Safety Inspection of Dams, the Department of the Army, Office of the Chief of Engineers (OCE), established criteria for rating the capacity of spillways. The recommended Spillway Design Flood (SDF) for the size (small, intermediate, or large) and hazard potential (low, significant, or high) classification of a dam is selected in accordance with the criteria. The SDF for those dams in the high hazard category varies between one-half of the Probable Maximum Flood (PMF) and the PMF. If the dam and spillway are not capable of passing the SDF without overtopping failure, the spillway capacity is rated as inadequate. If the dam and spillway are capable of passing one-half of the PMF without overtopping failure, or if the dam is not in the high hazard category, the spillway capacity is not rated as seriously inadequate. A spillway capacity is rated as seriously inadequate if all of the following conditions exist:

(a) There is a high hazard to loss of life from large flows downstream of the dam.

(b) Dam failure resulting from overtopping would significantly increase the hazard to loss of life downstream from the dam from that which would exist just before overtopping failure.

(c) The dam and spillway are not capable of passing one-half of the PMF without overtopping failure.

Description of Model:

If the Owner has not developed a PMF for the dam, the watershed is modeled with the HEC-1DB computer program, which was developed by the U.S. Army Corps of Engineers. The HEC-1DB computer program calculates a PMF runoff hydrograph (and percentages thereof) and routes the flows through both reservoirs and stream sections. In addition, it has the capability to simulate an overtopping dam failure. By modifying the rainfall criteria, it is also possible to model the 100-year flood with the program.

APPENDIX D

DELAWARE River Basin
Name of Stream: CARLEY BROOK
Name of Dam: FREETHY DAM
NDI ID No.: PA-00171
DER ID No.: 64-160
Latitude: N 41° 33.8' Longitude: W 75° 14.5'
Top of Dam Elevation: 1036.7 FEET
Streambed Elevation: 1011.0 Height of Dam: 26 ft
Reservoir Storage at Top of Dam Elevation: 89 acre-ft
Size Category: SMALL
Hazard Category: HIGH (see Section 5)
Spillway Design Flood: 1/2 PMF TO PMF (USE 1/2 PMF)
(SEE SECTION 5)

UPSTREAM DAMS

Name	Distance from Dam (miles)	Height (ft)	Storage at top of Dam Elevation (acre-ft)	Remarks
SCS PA-420	3.5	33	201	DER ID 64-185
UPPER WILCOX	5.2	18±	623	DER ID 64-63
BUNNELL'S	1.3	17	339	DER ID 64-29

DOWNSTREAM DAMS - NONE

DELAWARE River Basin

Name of Stream: CARLEY BROOK

Name of Dam: FREETHY DAM

DETERMINATION OF PMF RAINFALL & UNIT HYDROGRAPH

UNIT HYDROGRAPH DATA:

Sub-area	Drainage Area (square miles)	Cp (1)	Ct (2)	L miles (3)	L_{ca} miles (4)	L' miles (5)	Tp hours (6)	Map Area (7)	Plate (8)
A-1	0.9	0.45	1.23	1.33	0.76	N/A	1.23	1	A
A-2	0.6	0.45	1.23	N/A	N/A	0.51	0.82	1	A
A-3	9.5	0.45	1.23	7.39	3.51	N/A	3.27	1	A
A-4	1.3	0.45	1.23	1.55	0.74	N/A	1.28	1	A
Total	12.3								

(See Sketch on Sheet D-4)

(1) & (2): Snyder Unit Hydrograph coefficients supplied by Baltimore District, Corps of Engineers on maps and plates referenced in (7) & (8)

The following are measured from the outlet of the subarea:

(3): Length of main watercourse extended to divide

(4): Length of main watercourse to the centroid

The following is measured from the upstream end of the reservoir at normal pool:

(5): Length of main watercourse extended to divide

(6): $Tp=C_t \times (L \times L_{ca})^{0.3}$, except where the centroid of the subarea is located in the reservoir. Then $Tp=C_t \times (L')^{0.6}$

Initial flow is assumed at 1.5 cfs/sq. mile

Computer Data: QRCSN = -0.05 (5% of peak flow)
RTIOR = 2.0

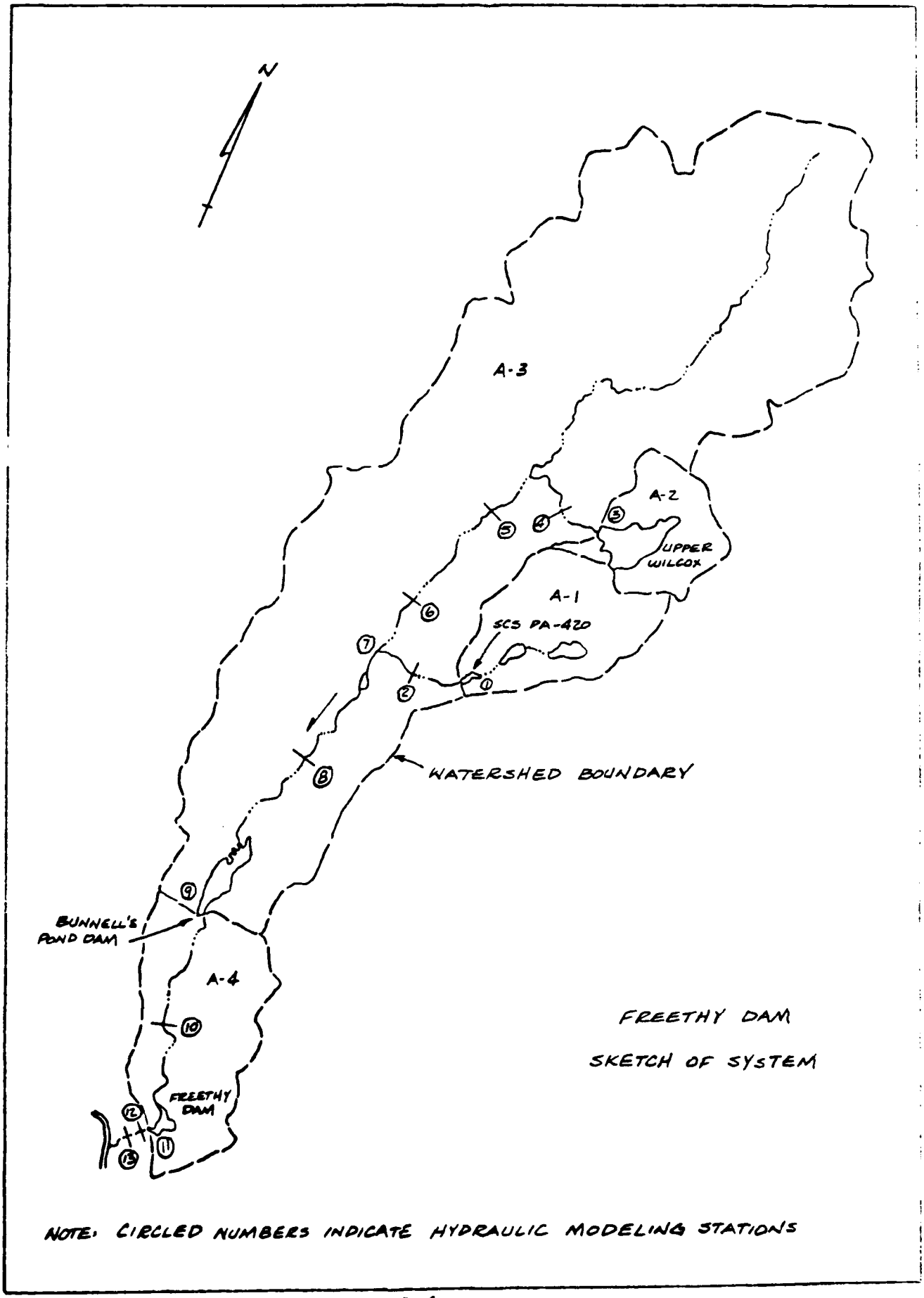
RAINFALL DATA:

PMF Rainfall Index= 21.2 in., 24 hr., 200 sq. mile

	Hydromet. 40 (Susquehanna Basin)	Hydromet. 33 (Other Basins)
Zone:	N/A	/
Geographic Adjustment Factor:		1.0
Revised Index Rainfall:		21.2

RAINFALL DISTRIBUTION (percent)

Time	Percent
6 hours	109
12 hours	121
24 hours	131
48 hours	140
72 hours	
96 hours	



FREETHY DAM

SKETCH OF SYSTEM

NOTE: CIRCLED NUMBERS INDICATE HYDRAULIC MODELING STATIONS

Data for Dam at Outlet of Subarea A-1 (See sketch on Sheet D-4)

Name of Dam: SCS PA-420

STORAGE DATA: THE FOLLOWING DATA WAS TAKEN FROM THE PHASE I REPORT FOR SCS PA-420, MAY 1980.

Elevation		Area (acres)	Storage million gals	Storage acre-ft		Remarks
1272.7	=ELEVO	0	0	0		
1281.4	=ELEV1	2.3 =A1		6.7	=S1	NORMAL POOL
1285.0		5.2				
1290.0		7.1				
1295.0		9.3				
1300.0		12.0				
1305.0		14.5				

* ELEVO = ELEV1 - $(3S_1/A_1)$

** Planimetered contour at least 10 feet above top of dam

Reservoir Area at Normal Pool is < 1 percent of subarea watershed.

BREACH DATA: BREACH ANALYSIS NOT REQUIRED

See Appendix B for sections and existing profile of the dam.

Soil Type from Visual Inspection: _____

Maximum Permissible Velocity (Plate 28, EM 1110-2-1601) _____ fps
(from $Q = CLH^{3/2} = V \cdot A$ and depth = (2/3) x H) & A = L·depth

HMAX = $(4/9\ V^2/C^2)$ = _____ ft., C = ____ Top of Dam El.= ____

HMAX + Top of Dam El. = _____ = FAILEL
(Above is elevation at which failure would start)

Dam Breach Data:

BRWID = _____ ft (width of bottom of breach)
Z = _____ (side slopes of breach)
ELBM = _____ (bottom of breach elevation, minimum of zero storage elevation)
WSEL = _____ (normal pool elevation)
T FAIL= _____ mins = _____ hrs (time for breach to develop)

Data for Dam at Outlet of Subarea A-1

Name of Dam: SCS PA-420

SPILLWAY DATA: TAKEN FROM PHASE I REPORT SCS PA-420, MAY 1980	Existing Conditions	Design Conditions
		(N/A)
Top of Dam Elevation	1304.3	
Spillway Crest Elevation	1281.4	
Spillway Head Available (ft)	22.9	
Type Spillway	DROP INLET	
"C" Value - Spillway	0.6 (ORIFICE)	
Crest Length - Spillway (ft)	N/A	
Spillway Peak Discharge (cfs)	130	
Auxiliary Spillway Crest Elev.	1298.4	
Auxiliary Spill. Head Avail. (ft)	5.9	
Type Auxiliary Spillway	VEGETATED CHANNEL	
"C" Value - Auxiliary Spill. (ft)	2.7	
Crest Length - Auxil. Spill. (ft)	125	
Auxiliary Spillway Peak Discharge (cfs)	5590	
Combined Spillway Discharge (cfs)	5720	

Spillway Rating Curve:

Elevation	Q Spillway (cfs)	Q Auxiliary Spillway (cfs)	Combined (cfs)
1281.4	0		0
1282.5	5		5
1285.0	11		11
1290.0	17		17
1296.8	23		23
1298.4	105	0	105
1299.65	121	487	605
1300.6	123	1165	1285
1302.2	126	2751	2877
1304.3	130	5590	5720

OUTLET WORKS RATING:	Outlet 1	Outlet 2	Outlet 3
	(N/A)	(N/A)	(N/A)
Invert of Outlet			
Invert of Inlet			
Type			
Diameter (ft) = D			
Length (ft) = L			
Area (sq. ft) = A			
N			
K Entrance			
K Exit			
K Friction=$29.1_N{}^2L/R^{4/3}$			
Sum of K			
$(1/K)^{0.5}$ = C			
Maximum Head (ft) = HM			
$Q = CA\sqrt{2g(HM)}$ (cfs)			
Q Combined (cfs)			

Data for Dam at Outlet of Subarea A-2 (See sketch on Sheet D-4)

Name of Dam: UPPER WILCOX POND

STORAGE DATA:

Elevation		Area (acres)		Storage million gals	acre-ft		Remarks
1412	=ELEVO	0		0	0		U.S. TOE
1426	=ELEV1	70	=A1	106	327	=S1	NORMAL POOL
1440**		87					

* ELEVO = ELEV1 - $(3S_1/A_1)$
** Planimetered contour at least 10 feet above top of dam

Reservoir Area at Normal Pool is 18 percent of subarea watershed.

BREACH DATA: BREACH ANALYSIS NOT REQUIRED

See Appendix B for sections and existing profile of the dam.

Soil Type from Visual Inspection: _____

Maximum Permissible Velocity (Plate 28, EM 1110-2-1601) _____ fps
(from $Q = CLH^{3/2} = V \cdot A$ and depth = (2/3) x H) & A = L·depth

HMAX = $(4/9\ V^2/C^2)$ = _____ ft., C = ____ Top of Dam El.= ____

HMAX + Top of Dam El. = _____ = FAILEL
(Above is elevation at which failure would start)

Dam Breach Data:

BRWID = _____ ft (width of bottom of breach)
Z = _____ (side slopes of breach)
ELBM = _____ (bottom of breach elevation, minimum of zero storage elevation)
WSEL = _____ (normal pool elevation)
T FAIL = _____ mins = _____ hrs (time for breach to develop)

Data for Dam at Outlet of Subarea A-2

Name of Dam: UPPER WILCOX POND

SPILLWAY DATA:	Existing Conditions	Design Conditions
Top of Dam Elevation	1430.1	(N/A)
Spillway Crest Elevation	1426.0	
Spillway Head Available (ft)	4.1	
Type Spillway	DROP INLET	
"C" Value - Spillway	N/A	
Crest Length - Spillway (ft)	N/A	
Spillway Peak Discharge (cfs)	90	
Auxiliary Spillway Crest Elev.		
Auxiliary Spill. Head Avail. (ft)		
Type Auxiliary Spillway		
"C" Value - Auxiliary Spill. (ft)	N/A	
Crest Length - Auxil. Spill. (ft)		
Auxiliary Spillway Peak Discharge (cfs)		
Combined Spillway Discharge (cfs)		

Spillway Rating Curve:

Elevation	Q Spillway (cfs)	Q Auxiliary Spillway (cfs)	Combined (cfs)
1426.0	0	N/A	N/A
1427.0	10		
1428.0	29		
1429.0	53		
1430.0	88		
1431.0	106		
1432.0	122		
1433.0	135		
1434.0	147		

OUTLET WORKS RATING:	Outlet 1	Outlet 2	Outlet 3
Invert of Outlet	(N/A)	(N/A)	(N/A)
Invert of Inlet			
Type			
Diameter (ft) = D			
Length (ft) = L			
Area (sq. ft) = A			
N			
K Entrance			
K Exit			
K Friction=$29.1_N{}^2L/R^{4/3}$			
Sum of K			
$(1/K)^{0.5} = C$			
Maximum Head (ft) = HM			
$Q = CA\sqrt{2g(HM)}$(cfs)			
Q Combined (cfs)			

BY _____ DATE _____ SUBJECT UPPER WILCOX POND SHEET NO _____ OF _____

CHKD BY _____ DATE _____ JOB NO _____

SPILLWAY RATING

① Calculate weir flow from spillway crest (1426.0) to elevation 1429.0 (top of conduit)

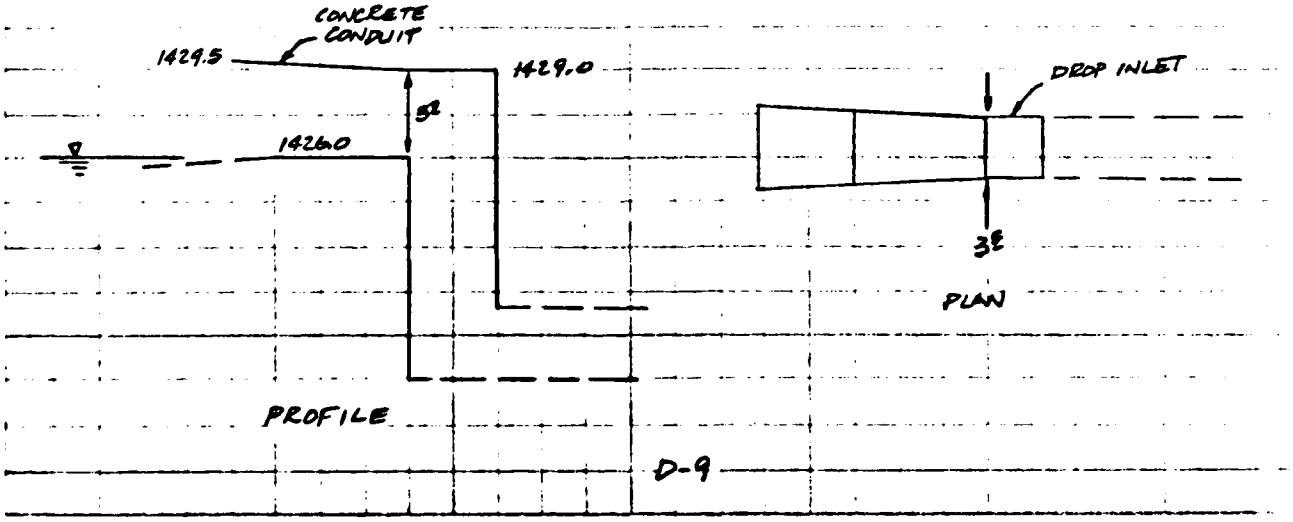
$$Q_w = C L H_w^{1.5} = 2.9(3.5) H_w^{1.5} = 10.15 H_w^{1.5}$$

② Calculate pressure flow above 1429.0

$$Q_p = C A \sqrt{2g H_p} = 0.7(3.0)(3.5)\sqrt{64.4}\, H_p^{0.5} = 59.0 H_p^{0.5}$$

ELEV	Hw	Hp*	Qw	Qp	Q
1426.0	0		0		0
1427.0	1		10		10
1428.0	2		29		29
1429.0	3		53		53
1430.0		2.25		88	88
1431.0		3.25		106	106
1432.0		4.25		122	122
1433.0		5.25		135	135
1434.0		6.25		147	147

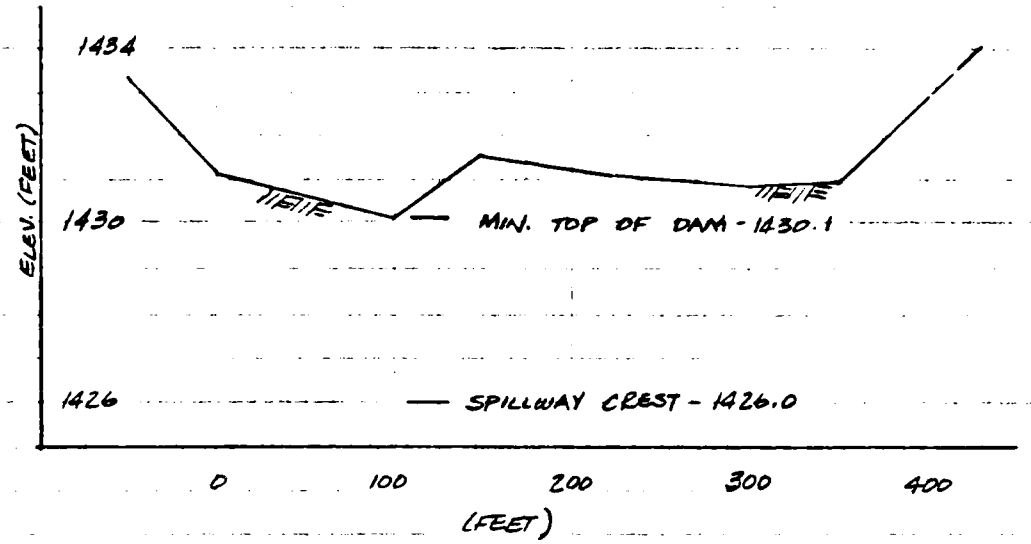
* Hp measured from center of orifice at 1427.75 feet



BY _____ DATE _____ SUBJECT UPPER WILCOX POND SHEET NO _____ OF _____

CHKD BY _____ DATE _____ JOB NO _____

TOP OF DAM PROFILE



$L	$Y
0	1430.1
95	1430.9
380	1431.7
390	1432.0
440	1433.0
500	1434.0

NOTE: All elevations are referenced to the reservoir pool level shown on USGS quadrangle, Galilee, PA.

Data for Dam at Outlet of Subarea A-3 (See sketch on Sheet D-4)

Name of Dam: BUNNELL'S POND

STORAGE DATA:

Elevation		Area (acres)		Storage million gals	Storage acre-ft		Remarks
1066	=ELEVO	0		0	0		D/S TOE
1079	=ELEV1	37	=A1	52	160	=S1	NORMAL POOL
1083.2		51		110	339		TOP OF DAM
1100**		108		-	-		

* ELEVO = ELEV1 - $(3S_1/A_1)$

** Planimetered contour at least 10 feet above top of dam

Reservoir Area at Normal Pool is 21 percent of subarea watershed.

BREACH DATA: BREACH ANALYSIS NOT REQUIRED

See Appendix B for sections and existing profile of the dam.

Soil Type from Visual Inspection: _____

Maximum Permissible Velocity (Plate 28, EM 1110-2-1601) _____ fps
(from $Q = CLH^{3/2} = V \cdot A$ and depth = (2/3) x H) & A = L·depth

HMAX = $(4/9\ V^2/C^2)$ = _____ ft., C = ____ Top of Dam El.= ____

HMAX + Top of Dam El. = _____ = FAILEL
(Above is elevation at which failure would start)

Dam Breach Data:

BRWID = _____ ft (width of bottom of breach)
Z = _____ (side slopes of breach)
ELBM = _____ (bottom of breach elevation, minimum of zero storage elevation)
WSEL = _____ (normal pool elevation)
T FAIL = _____ mins = _____ hrs (time for breach to develop)

Data for Dam at Outlet of Subarea A-3

Name of Dam: BUNNELL'S POND

SPILLWAY DATA:	Existing Conditions	Design Conditions
Top of Dam Elevation	1083.2	(N/A)
Spillway Crest Elevation	1079.0	
Spillway Head Available (ft)	4.2	
Type Spillway	CONCRETE BROAD CRESTED WEIR	
"C" Value - Spillway	2.65	
Crest Length - Spillway (ft)	116 (TOTAL - BOTH STAGES)	
Spillway Peak Discharge (cfs)	2475	
Auxiliary Spillway Crest Elev.		
Auxiliary Spill. Head Avail. (ft)		
Type Auxiliary Spillway		
"C" Value - Auxiliary Spill. (ft)	N/A	
Crest Length - Auxil. Spill. (ft)		
Auxiliary Spillway Peak Discharge (cfs)		
Combined Spillway Discharge (cfs)		

Spillway Rating Curve: SEE PAGE D-13

Elevation	Q Spillway (cfs)	Q Auxiliary Spillway (cfs)	Combined (cfs)
1079.0	0	N/A	N/A
1079.4	39		
1080.0	226		
1080.5	461		
1081.0	748		
1082.0	1446		
1083.0	2284		
1084.0	3241		
1085.0	4304		
1086.0	5463		

OUTLET WORKS RATING:	Outlet 1	Outlet 2	Outlet 3
Invert of Outlet	(N/A)	(N/A)	(N/A)
Invert of Inlet			
Type			
Diameter (ft) = D			
Length (ft) = L			
Area (sq. ft) = A			
N			
K Entrance			
K Exit			
K Friction $=29.1_N{}^2L/R^{4/3}$			
Sum of K			
$(1/K)^{0.5} = C$			
Maximum Head (ft) = HM			
$Q = CA\sqrt{2g(HM)}$ (cfs)			
Q Combined (cfs)			

BY _____ DATE _____ SUBJECT BUNNELL'S POND DAM SHEET NO _____ OF _____

CHKD BY _____ DATE _____ JOB NO _____

SPILLWAY RATING

Two stage broad-crested weir, C = 2.65 (Standard Handbook for Civil Engineers)

ELEV	H_1	H_2	Q_1	Q_2	Q_T
1079.0	0		0		0
1079.4	0.4	0	39	0	39
1080.0	1.0	0.6	154	72	226
1080.5	1.5	1.1	283	178	461
1081.0	2.0	1.6	436	312	748
1082.0	3.0	2.6	800	646	1446
1083.0	4.0	3.6	1232	1052	2284
1084.0	5.0	4.6	1722	1519	3241
1085.0	6.0	5.6	2263	2041	4304
1086.0	7.0	6.6	2852	2611	5463

$Q = C_L H^{1.5}$ $L_1 = L_2 = 58$ feet

$Q_1 = 2.65 (58) H_1^{1.5} = 154 H_1^{1.5}$

$Q_2 = 2.65 (58) H_2^{1.5} = 154 H_2^{1.5}$

TOP OF DAM RATING*

#L	#V
0	1083.2
115	1083.3
135	1083.5
175	1084.0
270	1085.0
460	1086.0

* TAKEN FROM PHASE I REPORT FOR BUNNELL'S POND DAM

Data for Dam at Outlet of Subarea A-4 (See sketch on Sheet D-4)

Name of Dam: FREETHY DAM

STORAGE DATA:

Elevation		Area (acres)		Storage million gals	Storage acre-ft		Remarks
1011	=ELEVO	0		0	0		
** 1035	=ELEV1	9	=A1	23	72	=S1	NORMAL POOL
** 1040		14					
** 1050		26					

* ELEVO = ELEV1 - $(3S_1/A_1)$

** Planimetered contour (USGS Quadrangle)

Reservoir Area at Normal Pool is ~1 percent of subarea watershed.

BREACH DATA: ALSO SEE SHEET D-18

See Appendix B for sections and existing profile of the dam.

Soil Type from Visual Inspection: WEATHERED ROCK

Maximum Permissible Velocity (Plate 28, EM 1110-2-1601) (N/A) fps
(from $Q = CLH^{3/2} = V \cdot A$ and depth = (2/3) x H) & A = L·depth

HMAX = $(4/9\ V^2/C^2)$ = _____ ft., C = ____ Top of Dam El.= ____

HMAX + Top of Dam El. = _____ = FAILEL (SEE SHEET D-28)
(Above is elevation at which failure would start)

Dam Breach Data:

BRWID = 50 ft (width of bottom of breach)
Z = 1.0 (side slopes of breach)
ELBM = 1020 (bottom of breach elevation)*

WSEL = 1035 (normal pool elevation)
T FAIL = 18 mins = 0.3 hrs (time for breach to develop)

* ESTIMATED TAILWATER ELEVATION

Data for Dam at Outlet of Subarea A-4

Name of Dam: FREETHY DAM

SPILLWAY DATA:	Existing Conditions	Design Conditions
Top of Dam Elevation	1036.7	
Spillway Crest Elevation	1035.0	
Spillway Head Available (ft)	1.7	
Type Spillway	CONCRETE WEIR	
"C" Value - Spillway	3.1	
Crest Length - Spillway (ft)	46.4	
Spillway Peak Discharge (cfs)	319	
Auxiliary Spillway Crest Elev.		
Auxiliary Spill. Head Avail. (ft)		
Type Auxiliary Spillway		
"C" Value - Auxiliary Spill. (ft)	N/A	
Crest Length - Auxil. Spill. (ft)		
Auxiliary Spillway Peak Discharge (cfs)		
Combined Spillway Discharge (cfs)		

Spillway Rating Curve: $Q = CLH^{1.5} = 3.1(46.4)H^{1.5} = 143.8H^{1.5}$

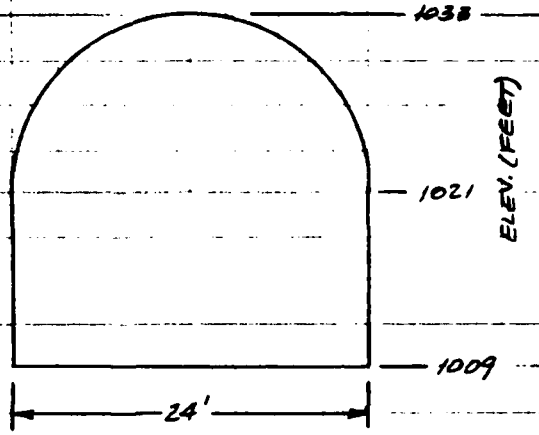
Elevation	Q Spillway (cfs)	Q Auxiliary Spillway (cfs)	Combined (cfs)

OUTLET WORKS RATING:	Outlet 1	Outlet 2	Outlet 3
Invert of Outlet	1016.2	(N/A)	(N/A)
Invert of Inlet	Unknown		
Type	STEEL PIPE		
Diameter (ft) = D	30"		
Length (ft) = L	20±		
Area (sq. ft) = A	4.91		
N	0.018		
K Entrance	1.0		
K Exit	0.5		
K Friction=$29.1N^2L/R^{4/3}$	0.35		
Sum of K	1.85		
$(1/K)^{0.5} = C$	0.74		
Maximum Head (ft) = HM	19.3		
$Q = CA\sqrt{2g(HM)}$ (cfs)	128		
Q Combined (cfs)	N/A		

BY REH DATE ____ SUBJECT FREETHY DAM SHEET NO ____ OF ____

CHKD BY ____ DATE ____ JOB NO ____

CULVERT DOWNSTREAM FROM FREETHY DAM



Assume water surface passes through critical depth within the culvert:

y_c (ft)	A (ft^2)	T (feet)	Q (cfs.)	V (ft/s.)	$V^2/2g$ (ft)	Pool Elev. (ft)
0						1009.0
2	48	24	385	8.02	1.0	1012.0
4	96		1090	11.35	2.0	1015.0
6	144		2002	13.90	3.0	1018.0
8	192		3082	16.05	4.0	1021.0
10	240		4307	17.95	5.0	1024.0
12	288	24	5661	19.66	6.0	1027.0
14	336	23.6	7194	21.41	7.2	1030.2
16	359	22.7	8101	22.57	7.9	1032.9

BEGIN PRESSURE FLOW ABOVE 1033 FEET

BY REH DATE ____ SUBJECT FREETHY DAM SHEET NO ____ OF ____

CHKD BY ____ DATE ____ JOB NO ____

CULVERT (CONTINUED)

Calculate pressure flow through culverts:

$Q = CA\sqrt{2gh}$ $C \cong 0.65$

h = pool elevation - 1021 (center of opening)

$A = 515\ ft^2$

Pool El. (feet)	h (ft.)	Q (cfs.)
1034	13	9686
1036	15	10,404
1038	17	11,076
1040	19	11,710
1042	21	12,310
1044	23	12,883
1046	25	13,431

Storage capacity between Freethy Dam and culvert:

Approximate area at elev 1040 = 1/2 acre

Storage at elev 1040 $\approx .5(31)(1/3) = 5$ A-F

$\therefore$ storage is minimal

Gage	D.A.	Maximum Recorded Flow July 1952	Maximum Recorded Flow Aug. 1955	Est. Flow at Freethy Dam[1]
Dyberry Creek at Dyberry, PA	63.2	15,500	11,400	4184/3077[2]
West Branch Lackawaxen River at Prompton, PA	59.7	2740	5860	774/1655[2]

[1] Estimated by $Q_2 = \left(DA_2/DA_1\right)^{0.8} \times Q_1$

where: Q_2 = Flow at Freethy Dam
Q_1 = Observed Flow at Gage
DA_1 = Drainage area at Gage
DA_2 = Drainage area at Freethy Dam

[2] 1952/1955

It is possible that Freethy Dam may have experienced floods in the range of 15-25% of the PMF. Some damage, the extent of which is unknown, was caused by the 1952 flood. Because of the limited gage information the flows calculated above are considered to be rough estimates. It is assumed for this study that the dam could not withstand much greater than 20% of the PMF.

BY _____ DATE _____
CHKD BY _____ DATE _____
SUBJECT FREETHY DAM GAGE COMPARISON
SHEET NO _____ OF _____
JOB NO _____

BY_____ DATE_____ SUBJECT FREETHY DAM SHEET NO._____ OF_____

CHKD. BY_____ DATE_____ JOB NO._____

SELECTED COMPUTER OUTPUT

87981

MULTI-RATIO ANALYSIS

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**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  01 APR 80
**********************************
    1                A1                    NATIONAL DAM INSPECTION PROGRAM
    2                A2                BALTIMORE DISTRICT CORPS OF ENGINEERS
    3                A3                          FREETHY DAM
    4                B     300       0      15       0       0       0       0       0      -4       0
    5                B1      5
    6                J       1       6       1
    7                J1    1.0     0.5     0.3     0.2     0.1    0.05
    8                K       0       1                                       1
    9                K1        INFLOW TO SCS PA-420
   10                M       1       1     0.9            12.3                                   1
   11                P               21.2    109     121     131     140
   12                T                                                       1    0.05
   13                W    1.23    0.45
   14                X    -1.5   -0.05     2.0
   15                K       1       1                                       1
   16                K1        ROUTE THROUGH SCS PA-420
   17                Y                                       1       0
   18                Y1      1                                               6.7      -1
   19                Y6 1281.4  1282.5    1285    1290  1296.8  1298.4 1299.65  1300.6  1302.2  1304.3
   20                Y5      0       5      11      17      23     105     608    1288    2877    5720
   21                SA      0     2.3     5.2     7.1     9.3      12    14.5
   22                SE 1272.7  1281.4    1285    1290    1295    1300    1305
   23                SS 1298.4  (EMERGENCY SPILLWAY CREST)
   24                SD 1304.3
   25                K       1       2                                       1
   26                K1        STREAM REACH 1 (STATION 2)
   27                Y                                       1       0
   28                Y1      1                                              -1
   29                Y6   0.08   0.045    0.08    1190    1205    3400   0.038
   30                Y7      0    1220      90    1200     110    1192     110    1190     115    1190
   31                Y7    115    1192     200    1200     310    1220
   32                K       0       3                                       1
   33                K1        INFLOW TO UPPER WILCOX POND
   34                M       1       1     0.6            12.3                                   1
   35                P               21.2    109     121     131     140
   36                T                                                       1    0.05             0.18
   37                W   0.82    0.45
   38                X    -1.5   -0.05     2.0
   39                K       1       3                                       1
   40                K1        ROUTE THROUGH UPPER WILCOX POND
   41                Y                                       1       0
   42                Y1      1                                           -1426      -1
   43                Y4   1426    1427    1428    1429    1430    1431    1432    1433    1434
   44                Y5      0      10      29      53      88     106     122     135     147
   45                SA      0      70      87
   46                SE   1412    1426    1440
   47                SS   1426
   48                SD 1430.1
   49                SL      0      95     380     390     440     500
   50                SV 1430.1  1430.9  1431.7  1432.0  1433.0  1434.0
```

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K      1       4                                                    1
K1       STREAM REACH 2 (STATION 4)
Y                                    1       0
Y1     1                                                         -1
Y6  0.08    0.045    0.08    1360    1375    4000   0.052
Y7     0     1400      50    1380     115    1362     115    1360     120    1360
Y7   120     1362     200    1380     260    1400
K      1       5                                                    1
K1       STREAM REACH 3 (STATION 5)
Y                                    1       0
Y1     1                                                         -1
Y6  0.08    0.045    0.08    1180    1195    4500   0.008
Y7     0     1220     150    1200     300    1182     300    1180     307    1180
Y7   307     1182     790    1200     900    1220
K      1       6                                                    1
K1       STREAM REACH 4 (STATION 6)
Y                                    1       0
Y1     1                                                         -1
Y6  0.08    0.045    0.08    1149    1164    4200   0.006
Y7     0     1180     100    1160     675    1152     675    1149     685    1149
Y7   685     1152     910    1160    1000    1180
K      2       7                                                    1
K1       COMBINE HYDROGRAPHS AT CONFLUENCE CARLEY BROOK AND PA-420 OUTFLOW
K      1       8                                                    1
K1       STREAM REACH 5 (STATION 8)
Y                                    1       0
Y1     1                                                         -1
Y6  0.08    0.045    0.08    1120    1135    8100   0.007
Y7     0     1160     150    1140     390    1123     390    1120     400    1120
Y7   400     1123     550    1140     730    1160
K      0       9                                                    1
K1       INFLOW TO BUNNELLS POND
H      1       1     9.5                    12.3
P             21.2     109     121     131     140
T                                                          1.0    0.05
W   3.27    0.45
X   -1.5   -0.05     2.0
K      2       9
K      1       9                                                    1
K1       ROUTE THROUGH BUNNELLS POND
Y                                    1       0
Y1     1                                                      -1079      -1
Y4  1079  1079.4    1080  1080.5    1081    1082    1083    1084    1085    1086
Y5     0      39     226     461     748    1446    2284    3241    4304    5463
SA     0      37     108
SE  1066    1079    1100
SS  1079
SD1083.2
SL     0     115     135     175     270     460
SV1083.2  1083.3  1083.5    1084    1085    1086
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101              K       1      10                                                      1
102              K1       STREAM REACH 6 (STATION 10)
103              V                                          1        0
104              Y1      1                                                           -1
105              Y6   0.08    0.045     0.08     1051     1075     6900    0.004
106              Y7      0     1080      400     1060      470     1054      470     1051      490     1051
107              Y7    490     1054      530     1060      660     1080
108              K       0       11                                                      1
109              K1       INFLOW TO FREETHY POND
110              M       1        1      1.3                12.3                                      1
111              P               21.2      109      121      131      140
112              T                                                              1.0     0.05              0.01
113              W    1.28     0.45
114              X    -1.5    -0.05      2.0
115              K       2       11
116              K       1       11                                                      1
117              K1       ROUTE THROUGH FREETHY DAM
118              Y                                          1        0
119              Y1      1                                                       -1035
120              SA      0        9       14       26
121              SE   1011     1035     1040     1050
122              SS   1035     46.4      3.1      1.5
123              SD1036.7
124              SL      0       38       57       60       64       71      100     131
125              SV1036.7  1036.9  1037.4     1038     1039     1040     1045     1050
126              K      99
```

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 1.00	RATIO 2 .50	RATIO 3 .30	RATIO 4 .20	RATIO 5 .10	RATIO 6 .05	
HYDROGRAPH AT	1	.90	1	2232.	1116.	670.	446.	223.	112.	SCS PA-420
	(	2.33)	(	63.20)(	31.60)(	18.96)(	12.64)(	6.32)(	3.16)(	
ROUTED TO	1	.90	1	2213.	1095.	577.	285.	21.	16.	
	(	2.33)	(	62.67)(	31.02)(	16.35)(	8.07)(	.60)(	.45)(	
ROUTED TO	2	.90	1	2208.	1096.	577.	280.	21.	16.	
	(	2.33)	(	62.52)(	31.03)(	16.33)(	7.93)(	.60)(	.45)(	
HYDROGRAPH AT	3	.60	1	1827.	914.	548.	365.	183.	91.	UPPER WILCOX
	(	1.55)	(	51.74)(	25.87)(	15.52)(	10.35)(	5.17)(	2.59)(	
ROUTED TO	3	.60	1	1086.	90.	43.	24.	9.	4.	
	(	1.55)	(	30.77)(	2.56)(	1.21)(	.68)(	.25)(	.13)(	
ROUTED TO	4	.60	1	1083.	90.	43.	24.	9.	4.	
	(	1.55)	(	30.68)(	2.56)(	1.21)(	.68)(	.25)(	.13)(	
ROUTED TO	5	.60	1	1039.	90.	43.	24.	9.	4.	
	(	1.55)	(	29.41)(	2.55)(	1.21)(	.68)(	.25)(	.13)(	
ROUTED TO	6	.60	1	961.	90.	43.	24.	9.	4.	
	(	1.55)	(	27.20)(	2.55)(	1.21)(	.68)(	.25)(	.13)(	
2 COMBINED	7	1.50	1	2525.	1131.	600.	299.	30.	20.	
	(	3.88)	(	71.49)(	32.03)(	17.00)(	8.47)(	.85)(	.57)(	
ROUTED TO	8	1.50	1	2478.	1032.	537.	257.	30.	20.	
	(	3.88)	(	70.16)(	29.23)(	15.20)(	7.27)(	.85)(	.57)(	
HYDROGRAPH AT	9	9.50	1	13305.	6652.	3991.	2661.	1330.	665.	BUNNELL'S POND
	(	24.60)	(	376.74)(	188.37)(	113.02)(	75.35)(	37.67)(	18.84)(	
2 COMBINED	9	11.00	1	15782.	7614.	4528.	2865.	1355.	681.	
	(	28.49)	(	446.90)(	215.62)(	128.22)(	81.14)(	38.36)(	19.28)(	
ROUTED TO	9	11.00	1	15721.	7584.	4472.	2788.	1296.	641.	
	(	28.49)	(	445.18)(	214.75)(	126.63)(	78.95)(	36.64)(	18.15)(	
ROUTED TO	10	11.00	1	15603.	7494.	4399.	2745.	1277.	632.	
	(	28.49)	(	441.84)(	212.22)(	124.55)(	77.72)(	36.16)(	17.90)(	
HYDROGRAPH AT	11	1.30	1	3147.	1573.	944.	629.	315.	157.	FIEETHY DAM
	(	3.37)	(	89.10)(	44.55)(	26.73)(	17.82)(	8.91)(	4.46)(	
2 COMBINED	11	12.30	1	17444.	8409.	4871.	2994.	1403.	690.	
	(	31.86)	(	493.96)(	238.13)(	137.94)(	84.77)(	39.73)(	19.53)(	

ROUTED TO	11	12.30 (31.86)	1	17437. (493.75)(	8399. 237.84)(	4858. 137.55)(	2987. 84.57)(	1400. 39.65)(	687. 19.46)(

SUMMARY OF DAM SAFETY ANALYSIS
SCS PA-420

PLAN 1 ••••••••••••••••

	INITIAL VALUE	EMERGENCY SPILLWAY CREST	TOP OF DAM
ELEVATION	1281.41	1298.40	1304.30
STORAGE	7.	126.	201.
OUTFLOW	.0	105.	5720.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	1301.53	0.00	163.	2213.	0.00	41.00	0.00
.50	1300.33	0.00	148.	1095.	0.00	41.25	0.00
.30	1299.57	0.00	139.	577.	0.00	42.00	0.00
.20	1298.85	0.00	131.	285.	0.00	43.00	0.00
.10	1294.57	0.00	87.	21.	0.00	47.25	0.00
.05	1289.01	0.00	44.	16.	0.00	46.25	0.00

PLAN 1 STATION 2

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	2208.	1197.7	41.25
.50	1096.	1196.1	41.25
.30	577.	1194.9	42.00
.20	280.	1193.8	43.25
.10	21.	1190.9	47.50
.05	16.	1190.7	46.50

stream section

D-25

Overtopping Summary

SUMMARY OF DAM SAFETY ANALYSIS

UPPER WILCOX

PLAN 1 ••••••••••••••••

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1426.00	1426.00	1430.10
STORAGE	327.	327.	623.
OUTFLOW	0.	0.	90.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	1431.94	1.84	763.	1086.	15.50	42.25	0.00
.50	1430.13	.03	625.	90.	2.25	45.25	0.00
.30	1428.57	0.00	510.	43.	0.00	45.50	0.00
.20	1427.75	0.00	451.	24.	0.00	46.00	0.00
.10	1426.89	0.00	390.	9.	0.00	46.75	0.00
.05	1426.45	0.00	358.	4.	0.00	46.50	0.00

PLAN 1 STATION 4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	1083.	1366.3	42.50
.50	90.	1362.1	45.25
.30	43.	1361.2	45.75
.20	24.	1360.9	46.00
.10	9.	1360.3	46.75
.05	4.	1360.2	46.75

PLAN 1 STATION 5

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	1039.	1186.0	42.75
.50	90.	1182.7	46.00
.30	43.	1181.8	46.00
.20	24.	1181.2	46.25
.10	9.	1180.6	47.50
.05	4.	1180.3	47.50

PLAN 1 STATION 6

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	961.	1154.6	43.25
.50	90.	1151.5	46.25
.30	43.	1150.5	46.50
.20	24.	1150.0	46.75
.10	9.	1149.4	48.50
.05	4.	1149.2	48.25

stream sections

PLAN 1 STATION 8

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	2478.	1129.5	43.00
.50	1032.	1127.1	42.00
.30	537.	1125.7	43.00
.20	257.	1124.3	43.75
.10	30.	1121.1	48.50
.05	20.	1120.9	47.75

stream section

SUMMARY OF DAM SAFETY ANALYSIS

BUNNELL'S POND

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1079.00	1079.00	1083.20
STORAGE	160.	160.	339.
OUTFLOW	0.	0.	2475.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	1087.67	4.47	584.	15721.	15.50	43.00	0.00
.50	1085.72	2.52	470.	7584.	10.25	43.00	0.00
.30	1084.52	1.32	405.	4472.	6.00	43.25	0.00
.20	1083.48	.28	353.	2788.	2.25	43.75	0.00
.10	1081.78	0.00	273.	1296.	0.00	43.75	0.00
.05	1080.81	0.00	232.	641.	0.00	44.00	0.00

PLAN 1 STATION 10

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	15603.	1069.4	43.50
.50	7494.	1065.3	43.50
.30	4399.	1062.8	43.75
.20	2745.	1060.9	44.25
.10	1277.	1058.2	44.25
.05	632.	1056.3	44.50

Stream section

SUMMARY OF DAM SAFETY ANALYSIS

FREETHY DAM

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1035.00	1035.00	1036.70
STORAGE	72.	72.	89.
OUTFLOW	0.	0.	319.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	1049.74	12.04	294.	17437.	35.25	43.25	0.00
.50	1044.28	7.58	199.	8399.	29.50	43.25	0.00
.30	1041.92	5.22	158.	4858.	24.50	43.75	0.00
.20	1040.35	3.65	134.	2987.	20.75	44.25	0.00
.10	1038.63	1.93	111.	1400.	15.00	44.00	0.00
.05	1037.57	.87	98.	687.	9.75	44.25	0.00

Overtopping Summary

BREACH ANALYSIS
(20% PMF)

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**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  01 APR 80
**********************************
    1                A1                    NATIONAL DAM INSPECTION PROGRAM
    2                A2                BALTIMORE DISTRICT CORPS OF ENGINEERS
    3                A3                          FREETHY DAM
    4                B     300       0       6       0       0       0       0       0      -4       0
    5                B1      5
    6                J       3       1       1
    7                J1    0.2
    8                K       0       1                                       1
    9                K1        INFLOW TO SCS PA-420
   10                M       1       1     0.9              12.3                                    1
   11                P               21.2    109     121     131
   12                T                                                       1    0.05
   13                W    1.23    0.45
   14                X    -1.5   -0.05     2.0
   15                K       1       1                                       1
   16                K1        ROUTE THROUGH SCS PA-420
   17                Y                                       1       1
   18                Y1      1                                               6.7      -1
   19                Y4 1281.4  1282.5    1285    1290    1296.8  1298.4  1299.65  1300.6  1302.2  1304.3
   20                Y5      0       5      11      17      23     105     608     1288    2877    5720
   21                SA      0     2.3     5.2     7.1     9.3      12    14.5
   22                SE 1272.7  1281.4    1285    1290    1295    1300    1305
   23                SS 1298.4
   24                SD 1304.3
   25                K       1       2                                       1
   26                K1        STREAM REACH 1 (STATION 2)
   27                Y                                       1       1
   28                Y1      1                                              -1
   29                Y6   0.08   0.045    0.08    1190    1205    3400   0.038
   30                Y7      0    1220      90    1200     110    1192     110    1190     115    1100
   31                Y7    115    1192     200    1200     310    1220
   32                K       0       3                                       1
   33                K1        INFLOW TO UPPER WILCOX POND
   34                M       1       1     0.6              12.3                                    1
   35                P               21.2    109     121     131
   36                T                                                       1    0.05             0.18
   37                W    0.82    0.45
   38                X    -1.5   -0.05     2.0
   39                K       1       3                                       1
   40                K1        ROUTE THROUGH UPPER WILCOX POND
   41                Y                                       1       1
   42                Y1      1                                           -1426      -1
   43                Y4   1426    1427    1428    1429    1430    1431    1432    1433    1434
   44                Y5      0      10      29      53      88     106     122     135     147
   45                SA      0      70      87
   46                SE   1412    1426    1440
   47                SS   1426
   48                SD 1430.1
   49                SL      0      95     380     390     440     500
   50                SV 1430.1  1430.9  1431.7  1432.0  1433.0  1434.0
```

```
K       1       4                                                       1
K1        STREAM REACH 2 (STATION 4)
Y                                       1       1
Y1      1                                                       -1
Y6   0.08    0.045     0.08     1360     1375     4000    0.052
Y7      0     1400       50     1380      115     1362      115     1360      120     1360
Y7    120     1362      200     1380      260     1400
K       1       5                                                       1
K1        STREAM REACH 3 (STATION 5)
Y                                       1       1
Y1      1                                                       -1
Y6   0.08    0.045     0.08     1180     1195     4500    0.008
Y7      0     1220      150     1200      300     1182      300     1180      307     1180
Y7    307     1182      790     1200      900     1220
K       1       6                                                       1
K1        STREAM REACH 4 (STATION 6)
Y                                       1       1
Y1      1                                                       -1
Y6   0.08    0.045     0.08     1149     1164     4200    0.006
Y7      0     1180      100     1160      675     1152      675     1149      685     1149
Y7    685     1152      910     1160     1000     1180
K       2       7                                                       1
K1        COMBINE HYDROGRAPHS AT CONFLUENCE CARLEY BROOK AND PA-420 OUTFLOW
K       1       8                                                       1
K1        STREAM REACH 5 (STATION 8)
Y                                       1       1
Y1      1                                                       -1
Y6   0.08    0.045     0.08     1120     1135     8100    0.007
Y7      0     1160      150     1140      390     1123      390     1120      400     1120
Y7    400     1123      550     1140      730     1160
K       0       9                                                       1
K1        INFLOW TO BUNNELLS POND
H       1       1       9.5             12.3                                            1
P               21.2      109      121      131
T                                                       1.0     0.05
W    3.27     0.45
X    -1.5    -0.05      2.0
K       2       9
K       1       9                                                       1
K1        ROUTE THROUGH BUNNELLS POND
Y                                       1       1
Y1      1                                                       -1079      -1
Y4    1079  1079.4     1080  1080.5     1081     1082     1083     1084     1085     1086
Y5       0       39      226      461      748     1446     2284     3241     4304     5463
SA       0       37      108
SE    1066     1079     1100
SS    1079
SD1083.2
SL       0      115      135      175      270      660
SV1083.2  1083.3  1083.5     1084     1085     1086
```

```
101  K      1      10                                                  1
102  K1       STREAM REACH 6 (STATION 10)
103  Y                                    1       1
104  Y1     1                                                        -1
105  Y6  0.08    0.045     0.08     1051     1075     6900    0.004
106  Y7     0     1080      400     1060      470     1054      470     1051      490     1051
107  Y7   490     1054      530     1060      660     1080
108  K      0      11                                                  1
109  K1       INFLOW TO FREETHY POND
110  M      1       1      1.3             12.3                                      1
111  P             21.2      109      121      131
112  T                                                          1.0     0.05              0.01
113  W   1.28    0.45
114  X   -1.5   -0.05      2.0
115  K      2      11
116  K      1      11                                                  1
117  K1       ROUTE THROUGH FREETHY DAM
118  Y                                    1       1
119  Y1     1                                                    -1035
120  $A     0       9      14      26
121  $E  1011    1035    1040    1050
122  $S  1035    46.4     3.1     1.5
123  $D1036.7
124  $L     0      38      57      60      64      71     100     131
125  $V1036.7  1036.9  1037.4    1038    1039    1040    1045    1050
126  $B    50     1.0    1020     0.3    1035    1045
127  $R    50     1.0    1020     0.3    1035  1038.2
128  $B    50     1.0    1020     0.3    1035  1039.7
129  K      1      12                                                  1
130  K1       ROUTE THROUGH CULVERT 150 FEET DOWNSTREAM FROM FREETHY DAM
131  Y                                    1       1
132  Y1     1                                                    -1009      -1
133  Y4  1009    1012    1015    1018    1021    1024    1027  1030.2  1032.9    1034
134  Y4  1036    1038    1040    1042    1044    1046
135  Y5     0     385    1090    2002    3082    4307    5661    7194    8101    9686
136  Y5 10404   11076   11710   12310   12883   13431
137  $A     0     1.0
138  $E  1009    1046
139  $S  1009
140  $D  1046
141  K      1      13                                                  1
142  K1       STREAM REACH 6 (STATION 13)
143  Y                                    1       1
144  Y1     1                                                        -1
145  Y6  0.08    0.05     0.08      992     1010      500   0.040
146  Y7     9    1015       48     1007       98     1007     120      992      160      992
147  Y7   172    1004      182     1015      190     1022
148  K     99
```

PLAN 1 - NO FAILURE
PLAN 2 - FAILURE 1.5' ABOVE DAM
PLAN 3 - FAILURE 3.0' ABOVE DAM

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .20	
HYDROGRAPH AT	1	.90 (2.33)	1	448. (12.68)(	SCS PA-420
			2	448. (12.68)(	
			3	448. (12.68)(	
ROUTED TO	1	.90 (2.33)	1	267. (7.56)(	
			2	267. (7.56)(	
			3	267. (7.56)(	
ROUTED TO	2	.90 (2.33)	1	262. (7.43)(	
			2	262. (7.43)(	
			3	262. (7.43)(	
HYDROGRAPH AT	3	.60 (1.55)	1	372. (10.52)(	UPPER WILCOX
			2	372. (10.52)(	
			3	372. (10.52)(	
ROUTED TO	3	.60 (1.55)	1	23. (.65)(	
			2	23. (.65)(	
			3	23. (.65)(	
ROUTED TO	4	.60 (1.55)	1	23. (.65)(	
			2	23. (.65)(	
			3	23. (.65)(	
ROUTED TO	5	.60 (1.55)	1	23. (.65)(	
			2	23. (.65)(	
			3	23.	

				(.65)(	
ROUTED TO	6	.60	1	23.	
	(	1.55)	(	.65)(	
			2	23.	
			(	.65)(	
			3	23.	
			(	.65)(	
2 COMBINED	7	1.50	1	280.	
	(	3.88)	(	7.92)(	
			2	280.	
			(	7.92)(	
			3	280.	
			(	7.92)(	
ROUTED TO	8	1.50	1	242.	
	(	3.88)	(	6.85)(	
			2	242.	
			(	6.85)(	
			3	242.	
			(	6.85)(	
HYDROGRAPH AT	9	9.50	1	2641.	
	(	24.60)	(	74.78)(	BUNNELLS POND
			2	2641.	
			(	74.78)(	
			3	2641.	
			(	74.78)(	
2 COMBINED	9	11.00	1	2804.	
	(	28.49)	(	79.39)(	
			2	2804.	
			(	79.39)(	
			3	2804.	
			(	79.39)(	
ROUTED TO	9	11.00	1	2734.	
	(	28.49)		77.41)(	
				2734.	
				77.41)(	
			3	2734.	
			(	77.41)(	
ROUTED TO	10	11.00	1	2693.	
	(	28.49)	(	76.25)(	
			2	2693.	
			(	76.25)(	
			3	2693.	
			(	76.25)(	
HYDROGRAPH AT	11	1.30	1	632.	
	(	3.37)	(	17.89)(	FREETHY DAM
			2	632.	
			(	17.89)(	
			3	632.	
			(	17.89)(	
2 COMBINED	11	12.30	1	2943.	
	(	31.86)	(	83.33)(	

			2 2943. (83.33)(	
			3 2943. (83.33)(	
ROUTED TO	11	12.30 (31.86)	1 2938. (83.18)(	
			2 7299. (206.69)(	FREETHY DAM
			3 9071. (256.87)(	
ROUTED TO	12	12.30 (31.86)	1 2938. (83.18)(	
			2 7156. (202.64)(	CULVERT
			3 8867. (251.08)(	
ROUTED TO	13	12.30 (31.86)	1 2937. (83.18)(	
			2 7092. (200.81)(	DAMAGE CENTER
			3 8788. (248.86)(	

SUMMARY OF DAM SAFETY ANALYSIS

FREETHY DAM

PLAN 1 ••••••••••••••••

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1035.00	1035.00	1036.70
STORAGE	72.	72.	89.
OUTFLOW	0.	0.	319.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	1040.30	3.60	133.	2938.	14.50	20.10	0.00

PLAN 2 ••••••••••••••••

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1035.00	1035.00	1036.70
STORAGE	72.	72.	89.
OUTFLOW	0.	0.	319.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	1038.23	1.53	106.	7299.	2.29	16.50	16.20

PLAN 3 ••••••••••••••••

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1035.00	1035.00	1036.70
STORAGE	72.	72.	89.
OUTFLOW	0.	0.	319.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	1039.71	3.01	125.	9071.	4.34	18.50	18.20

Breach Analysis and Channel Routing Summary

SUMMARY OF DAM SAFETY ANALYSIS

CULVERT

PLAN 1 ••••••••••••••••

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1009.00	1009.00	1046.00
STORAGE	0.	0.	12.
OUTFLOW	0.	0.	13431.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	1020.60	0.00	0.	2938.	0.00	20.10	0.00

PLAN 2 ••••••••••••••••

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1009.00	1009.00	1046.00
STORAGE	0.	0.	12.
OUTFLOW	0.	0.	13431.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	1030.12	0.00	2.	7156.	0.00	16.50	0.00

PLAN 3 ••••••••••••••••

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1009.00	1009.00	1046.00
STORAGE	0.	0.	12.
OUTFLOW	0.	0.	13431.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	1033.43	0.00	4.	8867.	0.00	18.50	0.00

PLAN 1 STATION 13

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.20	2937.	996.5	20.10

PLAN 2 STATION 13

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.20	7092.	999.5	16.50

Damage Center

D-37

Plan 3 - Station 13

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.20	8788.	1000.5	18.50

Damage Center

BY _____ DATE _____ SUBJECT FREETHY DAM SHEET NO _____ OF _____

CHKD BY _____ DATE _____ JOB NO _____

SUMMARY OF PERTINENT RESULTS

Multi-ratio Analysis:

	PMF	1/2 PMF	20% PMF
Rainfall (in.)	23.96	—	—
Runoff (in.)	21.59	10.80	4.32
Peak Inflow (cfs)	17,444	8409	2994
Peak Outflow (cfs)	17,437	8399	2987
Depth of Overtopping (ft.)	12.04	7.58	3.65
Duration of Overtopping (ft.)	35.25	29.50	20.75

Breach and Channel Routing Analysis (20% PMF):

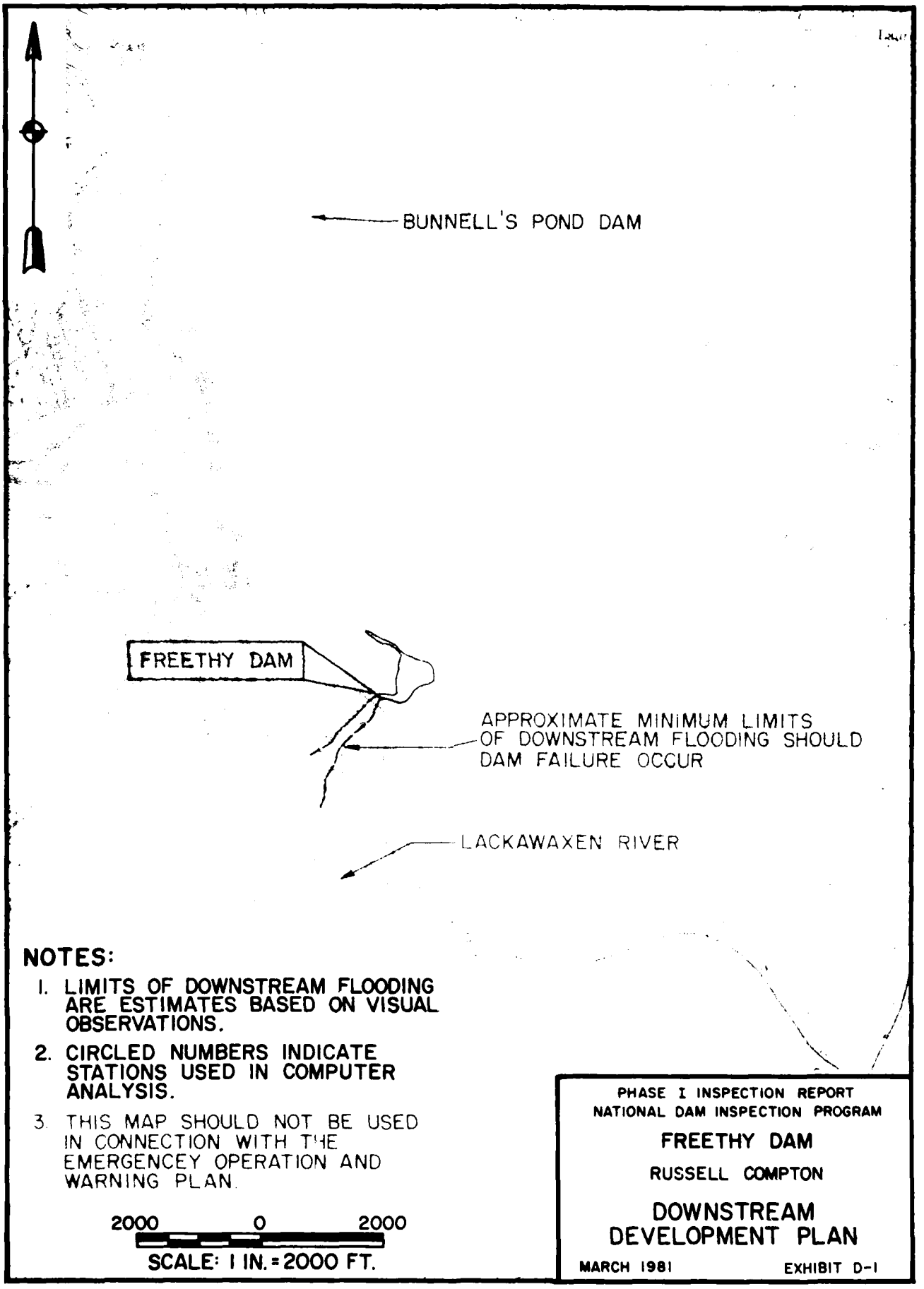
Plan 2:

	No failure	Failure	Difference
Peak Outflow (cfs)	2938	7299	4361
Stream Depth at Damage Center (ft)	4.5	7.5*	3.0

Plan 3

Peak Outflow (cfs)	2938	9071	6133
Stream Depth at Damage Center (ft.)	4.5	8.5*	4.0

*The depth of flooding could be substantially increased by bridges and other channel obstructions. Excessive damages may result from debris washed downstream from the dam.



NOTES:

1. LIMITS OF DOWNSTREAM FLOODING ARE ESTIMATES BASED ON VISUAL OBSERVATIONS.
2. CIRCLED NUMBERS INDICATE STATIONS USED IN COMPUTER ANALYSIS.
3. THIS MAP SHOULD NOT BE USED IN CONNECTION WITH THE EMERGENCEY OPERATION AND WARNING PLAN.

2000 0 2000

SCALE: 1 IN. = 2000 FT.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

FREETHY DAM

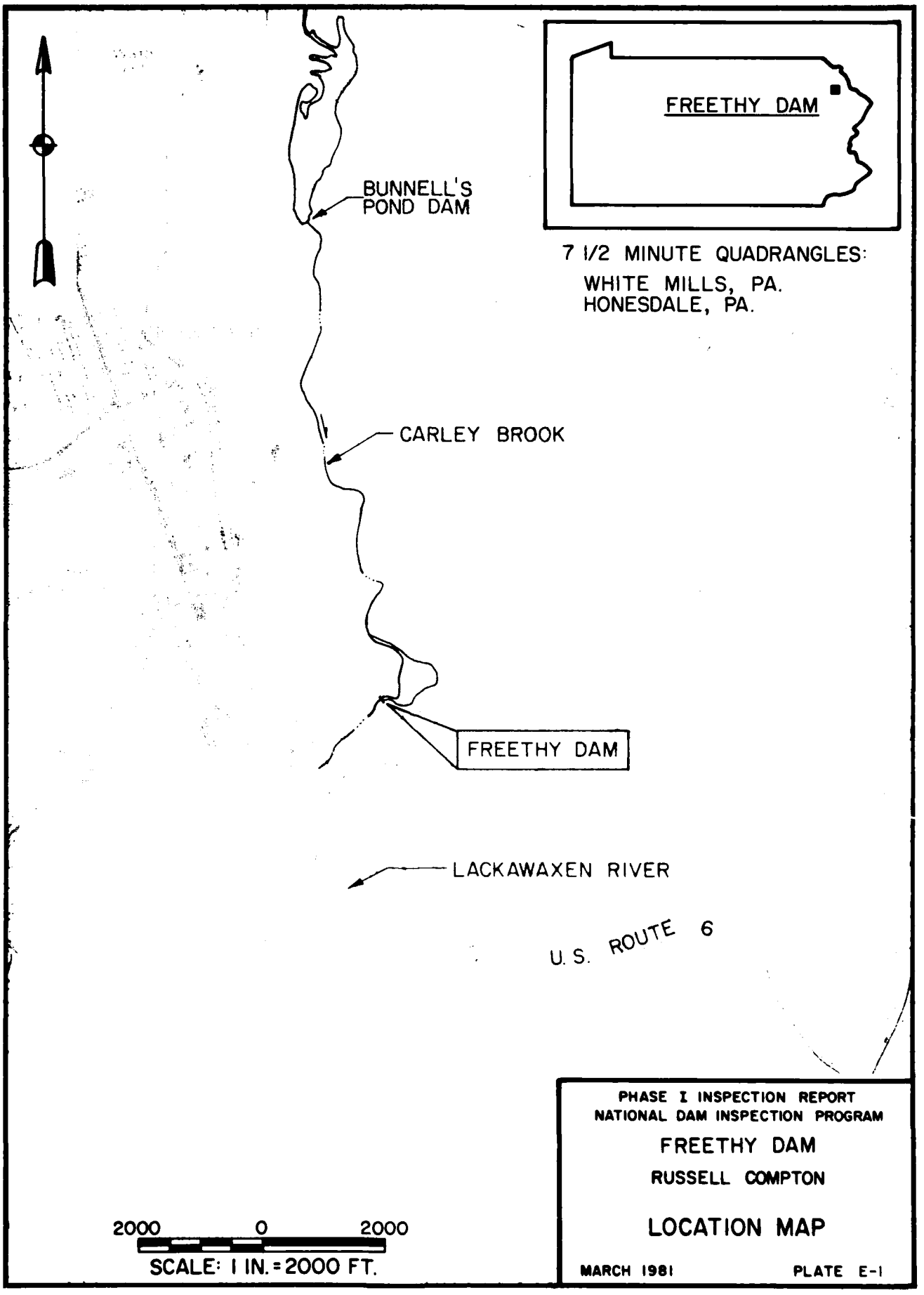
RUSSELL COMPTON

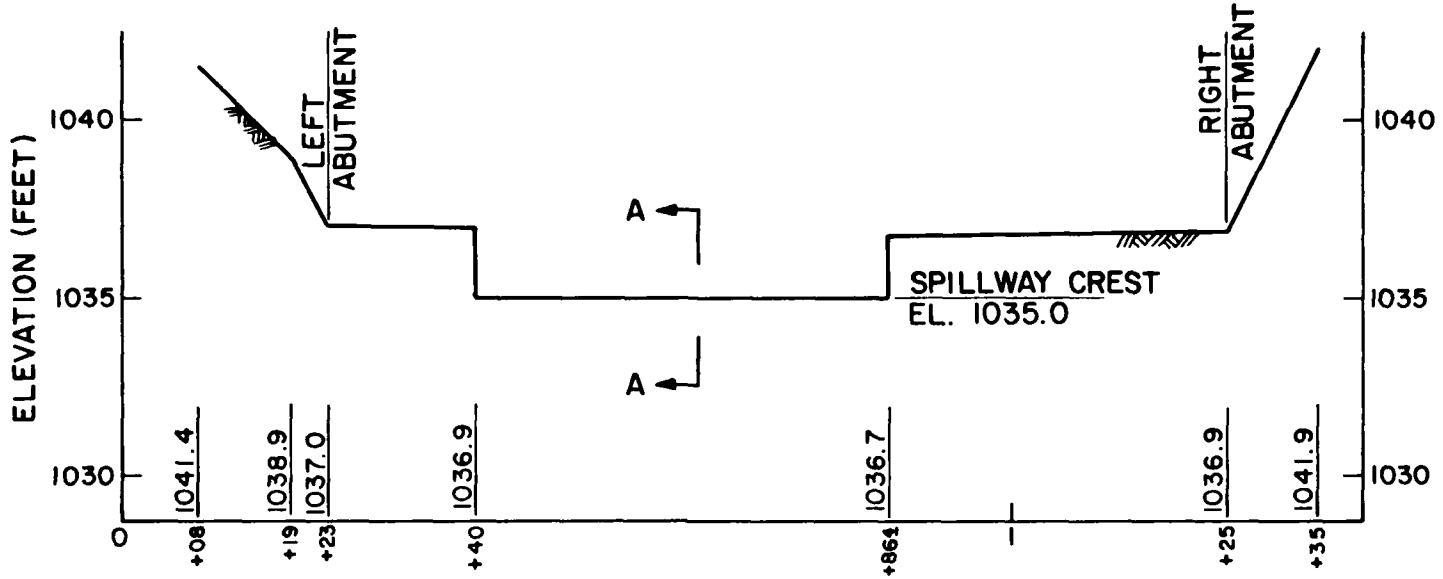
DOWNSTREAM DEVELOPMENT PLAN

MARCH 1981 EXHIBIT D-1

APPENDIX E

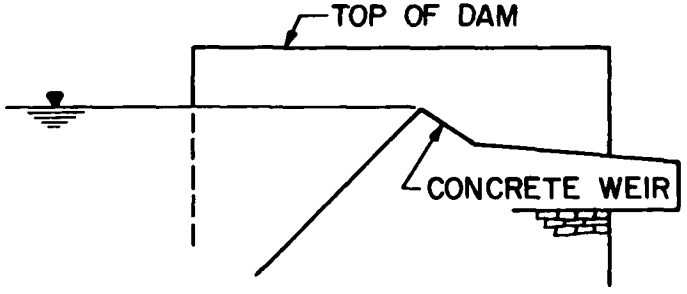
PLATES


FREETHY DAM
7 1/2 MINUTE QUADRANGLES:
WHITE MILLS, PA.
HONESDALE, PA.
BUNNELL'S
POND DAM
CARLEY BROOK
FREETHY DAM
LACKAWAXEN RIVER
U. S. ROUTE 6
2000 0 2000
SCALE: 1 IN. = 2000 FT.
PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
FREETHY DAM
RUSSELL COMPTON
LOCATION MAP
MARCH 1981
PLATE E-1



PROFILE-TOP OF DAM

SCALE- HORIZ.: 1 IN. = 20 FT.
VERT.: 1 IN. = 5 FT.



CROSS-SECTION A-A

SCALE: 1 IN. = 5 FT.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

FREETHY DAM

RUSSELL COMPTON

PROFILE-TOP OF DAM
SPILLWAY CROSS-SECTION

MARCH 1981

PLATE E-2

APPENDIX F

GEOLOGY

FREETHY DAM

APPENDIX F

GEOLOGY

Freethy Dam is located in Wayne County within the Appalachian Plateau Physiographic Province. The most pronounced topographic feature in the area is Camelback Mountain, which is part of the Pocono Plateau Escarpment. The escarpment has a well-defined, southwestward trend from Camelback Mountain; but it is irregular between Camelback Mountain and Mt. Pocono, which lies to the north. Streams east of the escarpment drain directly to the Delaware River, while those to the west drain to the Lehigh River.

The Pocono Plateau Section lies to the west of the escarpment. This area is relatively flat, with local relief seldom exceeding 100 feet. The topography has been greatly influenced by continental glaciation. Many features were created by deposition of glacial materials. The entire plateau lacks well-developed drainage.

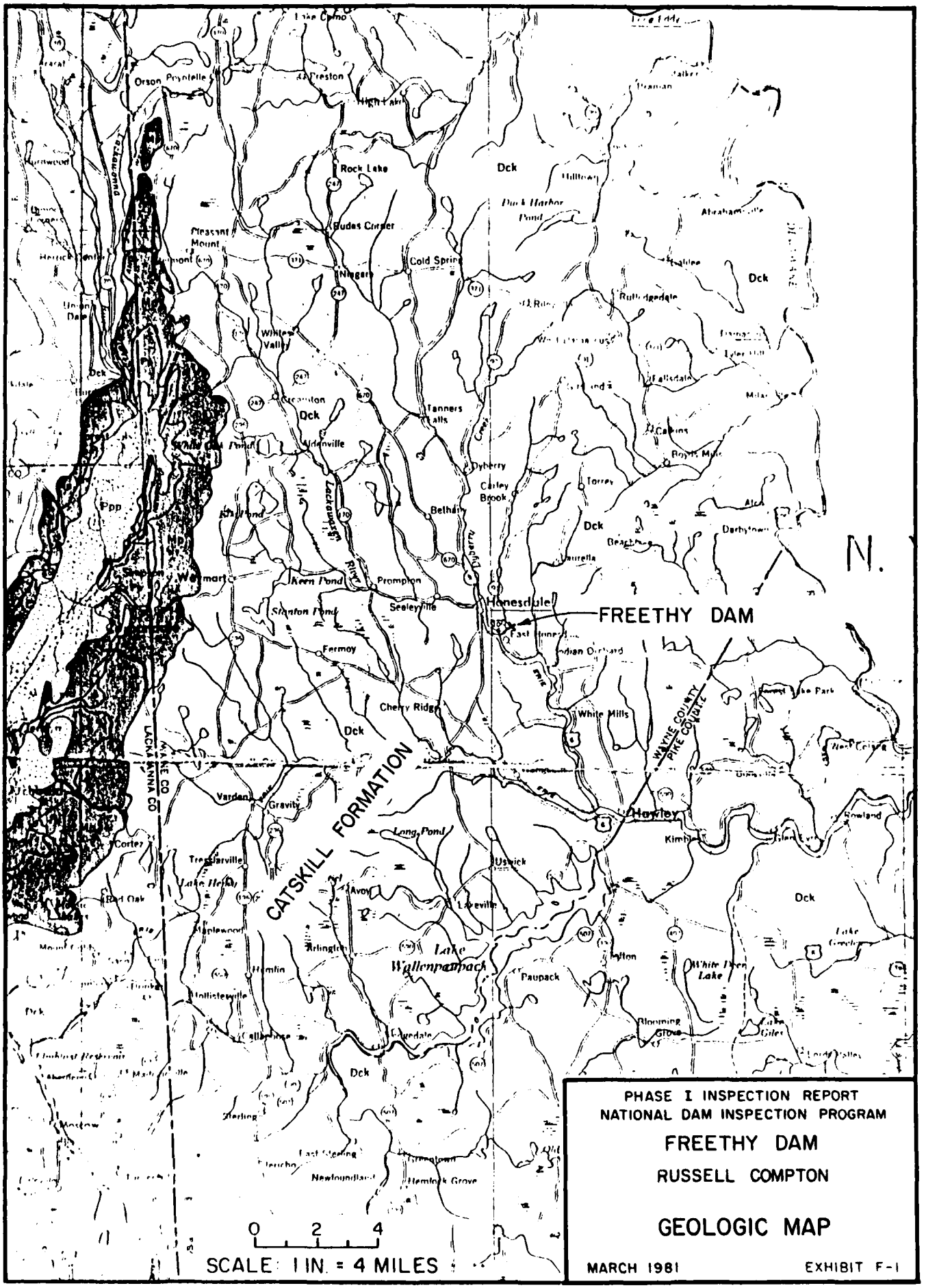
East of the escarpment is the Glaciated Low Plateaus Section of the province. This area is characterized by preglacial erosional topograhy with locally-thick glacial deposits. Local relief is generally 100 to 300 feet.

Bedrock units of the sections described above are the lithified sediments of offshore marine, marginal marine, deltaic environments, and fluvial environments associated with the Devonian Period. These units include siltstones of the Mahantango Formation, siltstones and shales of the Trimmers Rock Formation, and seven mapped members of the Catskill Formation. These members include sandstones, siltstones, and shales of the Towamensing Member; sandstone, siltsone and shale of the Walcksville Member; sandstones, siltstones and shale of the Beaverdam Run Member; sandstone and shale in the Long Run Member; sandstones and conglomerates in the Packerton Member; sandstones and some conglomerates in the Poplar Gap Member; and sandstones and conglomerates in the Duncannon Member.

Freethy Dam is underlain by the Catskill Formation. The Catskill Formation is predominantly red to brownish gray shales and sandstone with interbedded siltstones and conglomerates. Sandstones present are thick-bedded, fine- to coarse-grained and exhibit very low primary porosity due to a clay and silica matrix. Effective porosity results from fractures and parting planes.

The rocks are well-indurated and generally are not susceptible to slope failure; however, the presence of well-developed bedding and joint planes will result in some rockfall from vertical and high-angle cut slopes.

Bedrock is entirely overlain by glacial till of Late Wisconsin Age. This till is an unsorted mixture of clay, silt, sand, and gravel. It is moderately cohesive and is generally derived locally from the sandstones of the Catskill Formation. Thickness of the till varies from 5 to 75 feet.



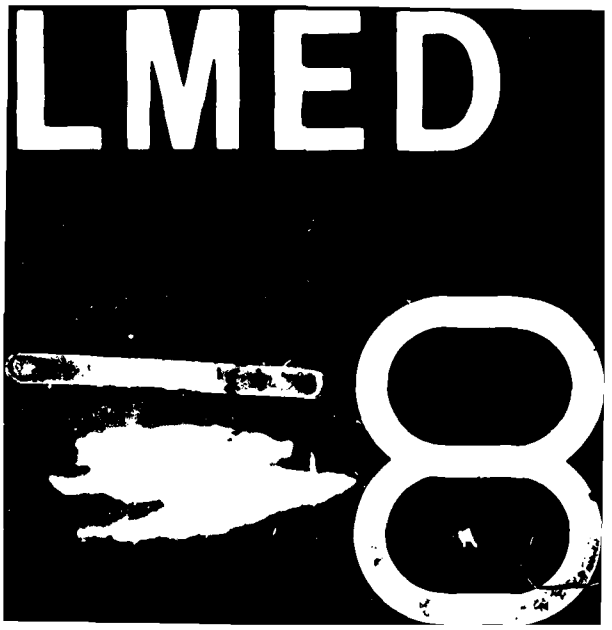
PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

FREETHY DAM

RUSSELL COMPTON

GEOLOGIC MAP

MARCH 1981 EXHIBIT F-1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